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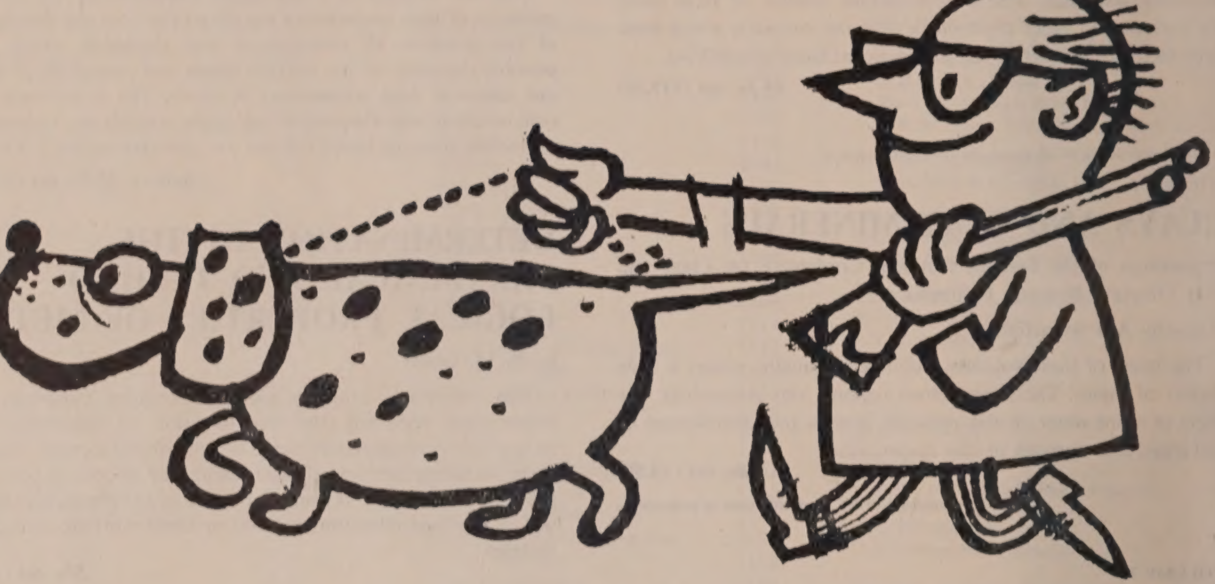

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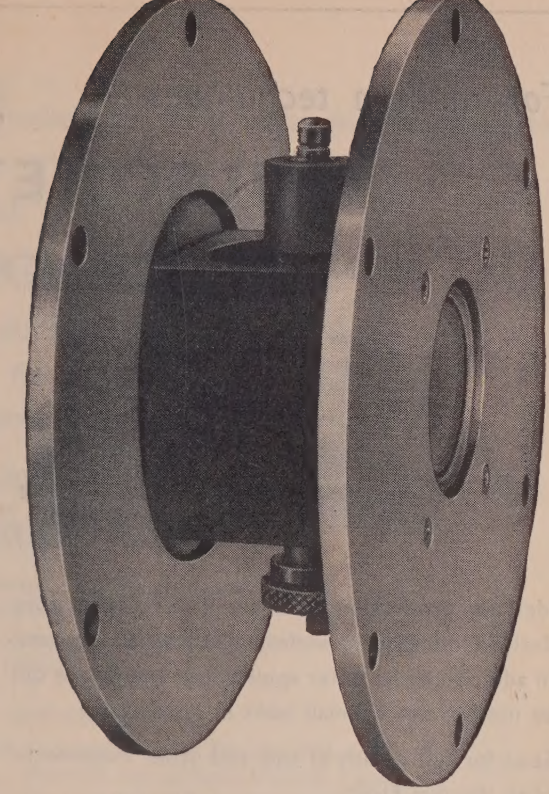

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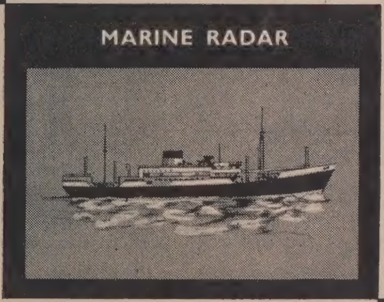

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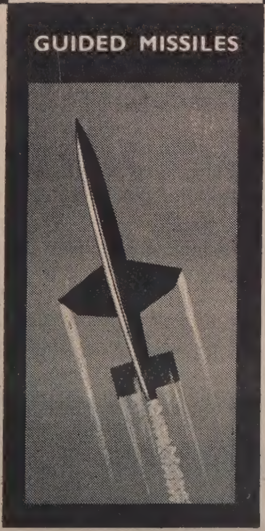

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Proceedings—Volume I

Physical Technical Part

Edited by Professor Dr. Gottfried Möllenstedt, Tübingen, Dr. Heinz Niehrs and Professor Dr. Ernst Ruska, Berlin

Quarto. With 1026 illustrations, xx + 851 pp. 1960 (109 contributions in English, 23 in French and 99 in German). Cloth: DM228.

SYNOPSIS OF THE CONTENTS

Preface by Ernst Ruska. Opening remarks by Vernon E. Cosslett. Lecture: History of Electronics by Max Von Laue. Electronics and Ionenoptical Elements, apparatus and methods, Cathode Lenses and dividing systems. Lens and their construction. Methods of picture projection. Photographic emulsions (and the effect of electronic influence on Silver Salines). Stereo advancement. Vacuum, Beam span, Lens Penetration. Irradiation microscope. Reflections and emission microscopy. Interference microscopy and X-Ray and projection microscopy. Electronics and X-Ray. Raster-microscopy—the pattern of closely spaced parallel lines formed in the fluorescent screen of a Cathode Ray Tube when the frame and line scanning currents or voltages are applied simultaneously, as for the reception of the picture. The image is formed by modulating the brightness of the different parts of the raster. The processing of material with electric radiation. The influence of the object (Glass) on radiation and image. The Strewing on the object and the image contrast. The building up of the crystal grating—periods—the further curving on the object and comparison of a "watered silk" pattern (q.v.) arising from interference between two line screens, and defect for which occasional uses are found. Electronicmicroscopy technical preparations: Foil carriers. Thin layers of the objective. Surface layers. Upsurge and depression process. Results of electronicmicroscopy in technology (Crystallography, metallurgy and chemistry): The structural aspect of the crystal grating. The growth of the crystal. The crystal upper layers. The condensed layers. The faults in the crystal formation and displacement. The transformation and separation rejection occurrences in metal. Natural and artificial technological fibres. Several products of chemical technics. Dust and smoke. Track formations. The field of microscopy. The field of electronic microscopy in the upper layers of metal. The adsorption proceedings on the field of Cathodes.

Proceedings—Volume II

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Edited by Professor Dr. Wolfgang Bargmann, Kiel, Dr. Dietrich Peters, Hamburg, and Dr. Carlheinrich Wolpers, Lübeck.

Quarto. With 650 illustrations, xv + 639 pp. 1960 (91 contributions in English, 18 in French and 57 in German) Cloth: DM196.

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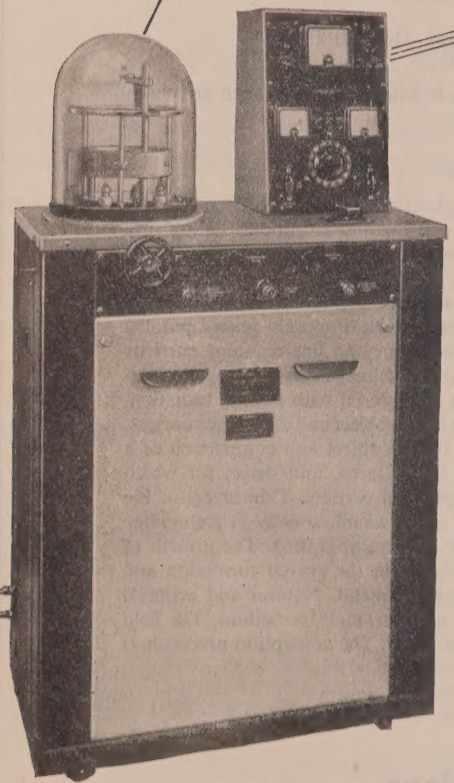

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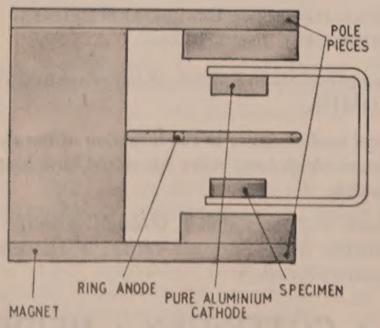

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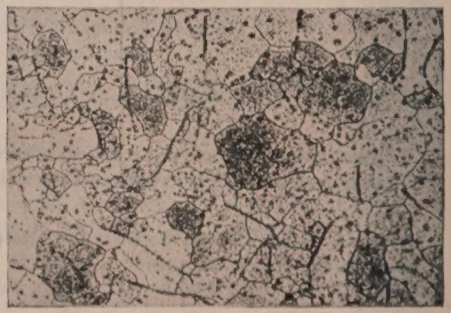

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PHYSICS ABSTRACTS

Volume 63 AUGUST 1960 Number 752

MATHEMATICS

517

PSEUDO-HERMITIAN SPACE.

10464 N.Delève.

Bull. Acad. Roy. Belgique Cl. Sci.,Vol. 45, No. 10, 960-5 (1959).
n French.

Considers the self-adjoint operators in a pseudo-hermitian space nd obtains their canonical forms. It is shown that the changes of oordinates in this space are the spinor transformations associated ith the proper rotations of the Minkowski space-time.

T.R.Carson

517

THE DEFINITION AND PROPERTIES OF THE 'GRILLES' (GRILLS) OF A SYMMETRIC DETERMINANT.

10465 I.Samuel.

Cahiers de Phys., Vol. 12, 478-82 (Dec., 1958). In French.

The author introduces and defines a new term - the 'grille' grill) of a determinant and indicates the useful applications of the oncept to problems in theoretical chemistry.

W.J.Orville-Thomas

517

ON THE DETERMINATION OF CERTAIN THERMODYNAMIC AND PHYSICAL QUANTITIES.

10466 A.Gleyzal.

Quart. appl. Math., Vol. 17, No. 3, 318-20 (Oct., 1959).

If z is a continuous differentiable function of two independent quantities x and y then $z = z(x, y)$ and $dz = F\,dx + G\,dy$, where $F = F(x, y) = \partial z/\partial x$, and $G = G(x, y) = \partial z/\partial y$. If furthermore G and y are readily measured but F and x not except that the family of curves $F = \text{const.}$ may be determined and at least two curves $x = \text{const.}$ found, then the quantities F and x themselves may be determined as functions of G and y.

W.Good

518 : 681.142

USE OF AN ELECTRONIC ANALOGUE COMPUTER WITH RESISTANCE NETWORK ANALOGUES.

10467 I.C.Hutcheon; J.P.K.Altes, L.Dekker and H.P.J.Gilissen.

Brit. J. appl. Phys., Vol. 10, No. 12, 542-3 (Dec., 1959).

A written discussion concerning a previous paper (Abstr. 6543 of 1960). Points are raised dealing with drift errors due to switch leakage and other effects in the analogue memory circuits. The authors of the original paper give the data required in a formal reply.

K.C.Garner

519 : 539.2 : 538.2

LIMITING PROPERTIES OF NUMBERS OF SELF-AVOIDING WALKS.

10468 J.M.Hammersley.

Phys. Rev., Vol. 118, No. 3, 656 (May 1, 1960).

A counter example is given to a conjecture of Fisher and Sykes (Abstr. 7154 of 1959) on the number of self-avoiding walks arising in the excluded volume problem in the Ising model of ferromagnetism.

ASTROPHYSICS

522 : 530.12

POSITIONAL ASTRONOMY AND GENERAL RELATIVITY.

10469 J.Lévy.

ahiers de Phys., Vol. 12, 437-66 (Nov., 1958). In French.

A careful analysis is made of approximations involved in the alculation of relativistic effects on planetary motion and light eviation, and the magnitudes of these effects are compared with hose of the errors of observation.

R.A.Newing

522.2

ADJUSTING THE POLAR AXIS OF AN ASTRONOMICAL TELESCOPE.

10470 H.Haffner.

Monthly Notes Astron. Soc. S. Africa, Vol. 19, No. 4, 30-40 (April 12, 960).

The usual method of determining the departure of the polar axis rom the celestial pole requires an accurate micrometer eyepiece nd an allowance for refraction to be made. An alternative method s suggested whereby the departure can be found from measurements n a photographic plate with freedom from errors due to refraction. he theory of the method and a few practical details are given.

R.W.Fish

522.2

DIFFRACTION PATTERNS PRODUCED BY OBSTRUCTIONS IN REFLECTING TELESCOPES OF MODEST IZE.

10471 E.Everhart and J.W.Kantorski.

stron. J., Vol. 64, No. 10, 455-63 (Dec., 1959).

The presence of a secondary mirror and its supports in a eflecting telescope causes considerable changes in the diffraction ttern which is the image of a star. Drawings are presented which ow in detail the modification of this pattern caused by central structions of various diameters. The fraction of the energy in the central disk of the pattern is calculated and this is found to decrease as the opaque central stop is made larger. The resulting deterioration in contrast is discussed. The diffraction spikes caused by supporting members of various widths and orientation are illustrated. In particular, the case of a central stop with four supporting struts is discussed in detail. The designs recommended for improved definition and contrast are those in which the obstructions have a minimum of area. Because of atmospheric seeing effects the results of this study are applicable primarily to telescopes of apertures less than about 20 inches used for high resolution studies under excellent seeing conditions.

522.5 : 535.33

HIGH-DISPERSION PHOTOELECTRIC SPECTROPHOTOMETER.

See Abstr. 10761

523

INTERGALACTIC MATTER AND THE GALAXY.

10472 F.D.Kahn and L.Woltjer.

Astrophys. J., Vol. 130, No. 3, 705-17 (Nov., 1959).

It is shown that the Local Group of galaxies can be dynamically stable only if it contains an appreciable amount of intergalactic matter. A detailed discussion shows that this matter consists mainly of ionized hydrogen and that stars can contribute only a small fraction to its total mass. The most likely values for the intergalactic temperature and density are found to be 5×10^5 degrees and 1×10^{-4} proton/cm^3, respectively. It is thought that this gas confines the halo. The distortion of the disk of the Galaxy, revealed by 21 cm observations, is analysed. This effect cannot be regarded as a relic from a primeval distortion, which occurred at the time of formation of the Galaxy; a more promising explanation for it can be given in terms of the flow pattern of the intergalactic gas past the Galaxy and of the resulting pressure distribution on the halo.

523

10473 NUMERICAL COMPUTATIONS ON THE EJECTION OF STARS INTO SPIRAL ARMS FROM GAS RINGS CONTAINING MAGNETIC FIELDS. A.Elvius and P.O.Lindblad.
Ark. Astron., Vol. 2, Paper 36, 393-406 (1959).

523

10474 ON THE GRAVITATIONAL INSTABILITY OF A MEDIUM IN NONUNIFORM ROTATION.
N.Bel and E.Schatzman.
Rev. mod. Phys., Vol. 30, No. 3, 1015, 1016 (July, 1958).

This two dimensional investigation is concerned with isothermal axially symmetric perturbations, the undisturbed density of the medium being uniform. R.A.Newing

523.1

10475 THE PHENOMENON OF THE RED-SHIFT AND THE HYPOTHESIS OF THE AGEING OF LIGHT.
S.Mavridès.
Cahiers de Phys., Vol. 12, 389-98 (Oct., 1958). In French.

This critical discussion of non-recession theories includes an account of A.T.Bogorodski's attempt to explain the red-shift in terms of a gravitational self-induction of the photon [Poulkovo Observatory Circular, No. 29 (1940)]. R.A.Newing

523.14

10476 VALIDITY OF THE CLOUD MODEL OF THE INTERSTELLAR MEDIUM. B.Donn.
Rev. mod. Phys., Vol. 30, No. 3, 940-1, 942 (July, 1958).

Attention is drawn to observations which show that the picture of the interstellar medium as made up of discrete clouds is an over simplification. An alternative model which considers random density fluctuations is proposed. R.D.Davies

523.16

10477 PARIS SYMPOSIUM ON RADIO ASTRONOMY. Edited by R.N.Bracewell.
Stanford, California: Stanford University Press (1959) xii + 612 pp.

The symposium was held in July-August 1958 under the joint sponsorship of the International Astronomical Union and the International Scientific Radio Union. The book records results reported, as subsequently submitted with revisions. There are six sections: (i) Moon and planets. (ii) The sun. (iii) Galacta and extragalactic radio sources. (iv) The large scale structure of galaxies. (v) Discrete sources and the universe. (vi) Mechanisms of solar and cosmic emission. For abstracts of selected papers see this or succeeding issues of Physics Abstracts.

523.16

10478 ON THE STRUCTURE OF TYPE IV BURSTS: THE CONTINUUM STORMS. M.Pick-Gutmann.
C.R.Acad. Sci. (Paris), Vol. 250, No. 12, 2127-9 (March 21, 1960). In French.

Type IV bursts are known to consist of two phases; the first lasts less than 15 minutes, and appears at centimetre and decimetre wavelengths while the second phase is continuum emission, and lasts longer and is generally found at metre wavelengths. 30 of the 47 centimetre bursts observed during the I.G.Y. showed the second phase and could be distinguished from type I bursts by their high continuum intensity. The continuum storms were always preceded by 3 or 3^+ flares. R.D.Davies

523.16

10479 APPARENT RADIO RADIATION AT 11 m WAVELENGTH FROM VENUS. J.D.Kraus.
Nature (London), Vol. 186, 462 (May 7, 1960).

Early reports by the author of radio emission from Venus are largely ascribed to terrestrial interference. Some records however cannot be entirely discarded and it is suggested that a further search should be made for emissions from Venus. R.D.Davies

523.16 : 537.56

10480 RADIO EMISSION FROM PLASMA SHOCKS. E.N.Parker and D.A.Tidman.
Phys. of Fluids, Vol. 3, No. 3, 369-72 (May-June, 1960).

From recent calculations of the efficiency of r.f. emission from longitudinal plasma oscillations, and from simple considerations of charge separation in collisionless plasma shocks, it is shown that one can predict a quantitative value for the energy of a type II solar radio burst in agreement with observation. Application of the same methods to the solar corona suggests that the radio spectrum of the quiet sun may be nonthermal below 20 Mc/s and that the solar wind may generate at earth as much as a megawatt of power at 1 Mc/s.

523.16

10481 THE NATURE OF THE COSMIC RADIO SOURCES. M.Ryle.
Proc. Roy. Soc. A, Vol. 248, 289-308 (Nov. 25, 1958).

A detailed consideration of the data available shows that it is difficult to account for the radio sources in terms of objects in the spiral arms or in the galactic halo. If it is assumed that most of the sources are extra-galactic then it appears that the radio luminosities must be very high, if the order observed in the colliding galaxies in Hydra, Hercules and Cygnus. The corresponding space density must be such that many of the sources detected are at distances at which the effects of the red shift are important, and hence provide a means of testing the predictions of the different cosmologi cal models. It is suggested that with the available data there appear to be a real discrepancy between the observations and the prediction of the steady state model. C.Hazard

523.16

10482 SYDNEY WORK ON 21-cm OBSERVATIONS ON THE H 1 GALACTIC DISK. F.J.Kerr.
Rev. mod. Phys., Vol. 30, No. 3, 924-5 (July, 1958).

The Sydney observations of the neutral hydrogen distribution in the Southern sky have been combined with those for the Northern sky The central part of the galactic hydrogen lies in a flat disk 250 parsecs thick at half density points. Hydrogen at more than 10 kpc from the galactic centre shows a systematic departure from the central plane. It was found that the ratio of neutral hydrogen to total mass increases as the distance from the galactic centre increases. R.D.Davies

523.16

10483 OBSERVATIONS OF THE RADIO SOURCE SAG A WITH HIGH RESOLVING POWER. Yu.N.Pariiskii.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 6, 1261-3 (Dec. 21, 1959). In Russian.

The beam widths to half-power points at the two wavelengths used, 3.2 cm and 9.4 cm, were 1.1' × 40' and 3.7' × 120', respectively. One of the three investigated components of the source is very probably due to the dense gaseous nucleus of the Galaxy. At a distance of 3 kps, its size is about 6 ps; it appears to be embedded in a source of non-thermal origin. G.A.Chisnall

523.1

10484 A SEARCH FOR NEUTRAL ATOMIC HYDROGEN IN GLOBULAR CLUSTERS. M.S.Roberts.
Nature (London), Vol. 184, 1555-6 (Nov. 14, 1959).

Theory suggests that globular clusters should contain a significant amount of diffuse matter ejected from the stars. Hydrogen-line observations were made on M3 and M13 with a 200 kc/s bandwidth. No emission was observed with an aerial temperature greater than 0.4°K. Upper limits to the amount of neutral hydrogen were estimated to be 100 and 200 solar masses respectively. This is less than the expected amount of intra-globular matter. A number of possible reasons for the discrepancy are given. R.D.Davie

523.16

10485 MONOCHROMATIC RADIO-WAVE RADIATION OF INTERSTELLAR HYDROGEN. J.Budejícký.
Slaboproudy Obzor, Vol. 21, No. 3, 163-72 (1960). In Czech.

The theory of radiation of the interstellar hydrogen is discusse and it is shown that the most intense and probable emission should occur at the wavelength of 21.1 cm. The width of the emitted line is extremely small, but in practice this is widened by the Doppler effect. The intensity of the hydrogen radiation can be measured by suitable radio-telescopes. The receiving telescopes of Christianse Hindman (1952), Bonn University and McGee—Murray are described in some detail. The results obtained by these instruments are reviewed and the radiation characteristics of the Galaxy are shown. The hydrogen absorption line, the distribution of the hydrogen in the region of Cygnus A and Cassiopeia A, and the red shift of the Galax are discussed. 31 refs. R.S.Sidorowic

523.1

10486 NOTE ON SOME OBSERVATIONAL CHARACTERISTIC OF METEOR RADIO ECHOES. P.M.Millman.
J. geophys. Res., Vol. 64, No. 12, 2192-4 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Attention is called to the observational evidence for meteor echoes from portions of the path well removed from the position of minimum range. Fading periods for echoes observed at Ottawa are given.

523.2

10487 PLASMA AND MAGNETIC FIELDS IN THE SOLAR SYSTEM. T.Gold.

J. geophys. Res., Vol. 64, No. 11, 1665-74 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). Discusses the configuration of the interplanetary moving magnetic fields that result from solar chromospheric events involving particle fluxes of ~1000/cm^3 and velocities of from 500 to 2000 km/sec. Consideration is given also to the role of the Van Allen layer in the production and maintenance of geomagnetic disturbances. D.R.Barber

523.3

10488 THE MOON.
G.P.Kuiper.

J. geophys. Res., Vol. 64, No. 11, 1713-19 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (See Abstr. 8521 of 1960). A review of existing empirical data on the surface features, and physical characteristics of the Moon derived from terrestrial observation. Future direct lunar exploration by means of rockets will add important information about the nature of the Moon's surface. There is still a real need for intensive and systematic studies from earth-bound observatories since only ~ 10% of the total derivable information has been collected to date at ground-based stations. D.R.Barber

523.3

10489 ABSENCE OF CRATERS ON THE FAR SIDE OF THE MOON. D.B.Beard.

Nature (London), Vol. 184, 1631 (Nov. 21, 1959).

The reported lower incidence of craters on the far side of the moon (unless due to inadequate photographic resolution) is explained by the effect of the earth's gravitation field on meteorites. F.Lachman

523.3 : 621.396.964

10490 SPACE RESEARCH IN RELATION TO THE MOON AND THE NEARER PLANETS. T.Gold.

Proc. Roy. Soc. A, Vol. 253, 487-91 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr. 8520 of 1960). A discussion of the techniques of space research, in the light of some major problems related to the solar system which still await solution. Space experiments involving landing on, or close approach to, the major planets will prove of immense value, and may yield quite unexpected results — comparable with the recent discovery of the Van Allen radiation zone. D.R.Barber

523.3

10491 THE LUNAR STRAIGHT WALL.
J.Ashbrook.

Publ. Astron. Soc. Pacific, Vol. 72, 55-8 (Feb., 1960).

Vertical height measurements along the length of the "Straight Wall" in Mare Nubium, determined from the lengths of sunrise shadows at seven selected points, yield altitudes ranging from 220 to 370 m with an uncertainty of ±24 m. D.R.Barber

523.3

10492 PHOTOGRAPHIC PHOTOMETRY OF THE PENUMBRA DURING THE LUNAR ECLIPSE OF 13-14 MARCH, 1957. M.Torelli.

R.C. Accad. Naz. Lincei., Vol. 28, No. 1, 50-6 (Jan., 1960). In Italian.

A comparison of the results with the theory of Link shows that there is an excess luminosity. J.M.Hough

523.4

10493 REMARKS ON MARS AND VENUS.
G.de Vaucouleurs.

J. geophys. Res., Vol. 64, No. 11, 1739-44 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). The significant astronomical and astrophysical facts, together with the rather fragmentary geophysical data for the two planets, are reviewed. These include tabulated information on (1) orbital elements; (2) physical elements; (3) atmospheric composition; (4) planetary temperatures (black-body, grey-body and radiometric) and densities. Recent researches on the Venusian clouds, and the new infrared absorption bands in the Martian atmosphere (Sinton, 1958) are discussed. D.R.Barber

523.4 : 551.5

10494 OUTER ATMOSPHERES OF THE EARTH AND PLANETS.
R.Jastrow.

J. geophys. Res., Vol. 64, No. 11, 1789-98 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). The salient features of the atmospheres of Mars and Venus are compared with those of the earth's atmosphere so far as the very limited observations will allow. A discussion of the lunar atmosphere, in relation to the probable effects of solar corpuscular bombardment, is included; and it is considered that the lunar atmospheric density is 10^{-11} to 10^{-15} that of the earth. D.R.Barber

523.5

10495 SOLID PARTICLES IN THE SOLAR SYSTEM.
F.L.Whipple.

J. geophys. Res., Vol. 64, No. 11, 1653-64 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (See Abstr 8521 of 1960). A detailed survey of the researches that the author considers should be conducted both in space and from the surface of the earth. It is emphasized that most of the necessary information can be obtained from ground based meteoritic studies at a fraction of the effort required for space vehicle experiments. Only a small fraction of the possible and necessary ground based pure astronomical observations have been made and very little laboratory work carried out. Extensive studies from space vehicles are needed only to discover unexpected meteor streams or characteristics of meteoritic material in space. C.Hazard

523.5

10496 CALCULATION OF EROSION IN SPACE FROM THE COSMIC RAY EXPOSURE AGES OF METEORITES.

F.L.Whipple and E.L.Fireman.

Nature, Vol. 183, 1315 (May 9, 1959).

The argon exposure age of the Sikhote—Alin meteorite is estimated as 5 × 10^8 yrs. If erosion occurs in space this is less than true exposure age, and is shown to set an upper limit of 1.5 × 10^{-7} cm/yr. to the rate of erosion of an iron meteorite in space. C.Hazard

523.5

10497 EROSION OF METEORITES IN SPACE AND THE DENSITY OF INTERPLANETARY GAS. L.Reiffel.

Nature (London), Vol. 185, 821-3 (March 19, 1960).

On the assumption that the etching of the Sikhote—Alin meteorite is due solely to sputtering from solar protons, Whipple has estimated the maximum possible solar proton density of interplanetary space in the vicinity of the earth. It is pointed out that helium erosion possibly exceeds that dueto hydrogen and consequently Whipple's upper limit must be considerably reduced. The revised figures are lower by about one order of magnitude then the figures deduced from a variety of astrophysical and geophysical phenomena and which tend to be confirmed by some recent Russian observations. Recent observations on sputtering in the laboratory give lower values then those used by Whipple and may account for the discrepancy. Alternatively the average solar proton velocities may be less then usually assumed. A number of other reasons are given for treating the calculations with caution. C.Hazard

523.5

10498 PRIMARY AND SECONDARY OBJECTS.
H.C.Urey.

J. geophys. Res., Vol. 64, No. 11, 1721-37 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). In reviewing ancient and modern observations of meteorites it is suggested that two different groups of objects, termed "primary", and "secondary", are required to explain the observed properties of chondritic meteorites. The primaries approximate to the Moon in size; whilst the secondaries may be identified as regions on the surface of the primary objects e.g. on the lunar surface. The latter may indeed be the place of origin of the stony meteorites. In support of this there is evidence that the stony and iron meteorites do not come from the same region in space and have quite different ages, the former being much the younger. Future lunar exploration by probe and space vehicle should provide important new information concerning the conclusions outlined above. D.R.Barber

523.5

10499 DO METEORITES EXIST CONSISTING PREDOMINANTLY OF FELDSPAR? K.Przibram.

Nature (London), Vol. 186, 300-1 (April 23, 1960).

Samples of meteorites were tested with ultraviolet excitation for fluorescence. Since the samples consisted predominantly of olivine, which in the terrestrial form shows no fluorescence, the negative results obtained are not surprising. The author is anxious to discover whether meteorites consisting predominantly of feldspar (anorthite) exist, and if so, to obtain samples of them. Such meteorites are expected to exhibit fluorescent properties. C.F.Barnaby

523.7 : 551.5

LIGHTWEIGHT SUNTRACKER FOR BALLOON APPLICATIONS. See Abstr. 10399

523.73

10500 SOLAR ROTATION AND ISOROTATION. A.J.Meadows.

Publ. Astron. Soc. Pacific, Vol. 72, 58-9 (Feb., 1960).

A significant difference of +0.2 km/sec exists in the mean velocity of rotation derived from spectral lines originating at chromospheric levels as compared with that obtained from photospheric lines. This result is at variance with that to be expected from the theory of isorotation, based on the tacit assumption of the existence of a general solar magnetic field. A cause of the discrepancy may be the non-uniform distribution of the latter since the Babcock solar magnetograms have shown that a general field exists only at high solar latitudes where very few measurements of the rotational velocity have been made spectroscopically. Such results as are available, however, appear to show the same variation of velocity with height in the solar atmosphere as is found for regions near the sun's equator. More detailed observations are necessary to settle this point. D.R.Barber

523.74

10501 AN ESTIMATE OF THE PEAK SUNSPOT NUMBER IN 1968. C.M.Minnis.

Nature (London), Vol. 186, 462 (May 7, 1960).

The peak sunspot numbers during the last 20 sunspot cycles have been used in several different ways to predict the peak number in 1968. There is a probability of 0.75 that it will be in the range 110 to 160. R.D.Davies

523.74 : 537.59

10502 SMALL EFFECTS OF SOLAR FLARES AND THE ENERGY SPECTRUM OF PRIMARY VARIATION OF COSMIC RAYS. E.V.Kolomeets.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1351-3 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 960-6 (Nov., 1959).

The relation between the intensity of cosmic-ray neutrons and chromospheric flares was studied from the data obtained at four stations located at various latitudes—Alma-Ata, Rôme, Göttingen (2 stations). By the epoch-superposition method, a small flare effect has been found at each of these stations. The energy spectrum of particles of the supplementary flux has been determined with the aid of the coupling constants.

523.74 : 537.59

SOLAR ACTIVITY AND TRANSIENT DECREASES IN COSMIC-RAY INTENSITY. See Abstr. 9478

523.74 : 537.59

LOW-ENERGY COSMIC-RAY EVENTS ASSOCIATED WITH SOLAR FLARES. See Abstr. 9479

523.75 : 536.59

PRIMARY COSMIC RAYS DURING SOLAR DISTURBANCES. See Abstr. 9480

523.75

10503 DISTRIBUTION OF MATTER WITH TEMPERATURE IN THE EMISSION CORONA. D.E.Billings.

Astrophys. J., Vol. 130, No. 3, 961-71 (Nov., 1959).

Analysis of over one thousand profiles of the coronal emission lines λ 5303 and λ 6374 yields (a) an empirical multiplier for converting S-wave ionization cross-sections for Fe XIV to total cross-sections and (b) the relative amount of coronal matter as a function of temperature in each of the following situations: (1) in sunspot latitudes during the winter of 1956-1957; (2) in specific coronal regions; and (3) in polar regions. All the distributions but one maximized at or near 2.4×10^{6}°K. This distribution, in a region emitting λ 5694 o Ca XV, maximized at a temperature higher than 3×10^{6}°K.

523.75

10504 EXTENSION OF THE SOLAR CORONA INTO INTERPLANETARY SPACE. E.Parker.

J. geophys. Res., Vol. 64, No. 11, 1675-81 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). Various sources of indirect observation agree in providing evidence for an extension of the corona out to at least the Martian orbit, and, under intense solar excitation, to perhaps as far as the orbit of Jupiter. The extension is in the form of an ionized solar gas - the "solar wind" - moving outwards in a radial magneti field of 10^{-5} G mean intensity. The velocity of such solar streams may attain values of 1500-2000 km/sec, with a maximum particle density $\sim 10^{4}/\text{cm}^{3}$. Space-probe methods are suggested that should lead to a direct verification of the above quantitative limits. D.R.Barber

523.75

10505 SURVEY OF NUMBER OF SOLAR FLARES OBSERVED DURING THE INTERNATIONAL GEOPHYSICAL YEAR. H.W.Dodson and E.R.Hedeman.

J. geophys. Res., Vol. 65, No. 1, 123-32 (Jan., 1960).

According to the McMath—Hulbert Observatory working list of world-wide flares there were more than 6700 solar events during the I.G.Y. for which at least one observer estimated the importance to be ≥ 1. According to reports to World Data Centres the flare patrol was gratifyingly complete and uniform. However, examinatio of the starting times of the reported flares reveals evidence for a serious lack of homogeneity in the I.G.Y. flare data. Approximately twice as many flares, ≥ 1, were reported per hour from 05 h to 16 h U.T. as during the remainder of the Universal Day. This strong dependence on U.T. exists in the flare data for each month of the I.G.Y Examination of the patrol hours and flare reports for May and July 1958 for each of the 19 Hα cinematographic patrol stations shows that the principal photographic patrol stations fail to confirm the ver high rate of flare occurrence for 05 h to 16 h U.T. that appears in the total I.G.Y. data. Visual observations between 05 h and 16 h U.T. apparently constitute the principal source of inhomogeneity in the flare data. For the hours 17 to 04 in the Universal Day the I.G.Y. flare reports are based primarily on the cinematographic patrol. Comparison of the number of flares and subflares indicates that in the I.G.Y. data for the hours 05 to 16 U.T. many flare events are listed as flares that probably would have been classified as subflares b the principal cinematographic observers.

523.7

10506 THE LARGE SOLAR FLARES OF JULY 10 AND 14, 195 P.Chen.

Science Record (China), New Series, Vol. 3, No. 12, 635-9 (Dec., 1959).

A description, with Hα photograms and spectrograms, of two 3^{+} flares. Photometry of the flare images gave indications of successive brightening and fading of adjacent emission regions. From their linear separation, and the time interval between brightening and fading for the same individual feature, a velocity of propagation of 2×10^{6} cm/sec was deduced. Magnetohydrodynamic considerations gave for the scale height of flare activity a value of 3.57×10^{6} cm — many times smaller than the total depth of the solar convective layer. D.R.Barbe

523.75 : 537.5

10507 ON THE STRUCTURE OF SOLAR CORPUSCULAR STREAMS AND THE INTERPLANETARY MEDIUM. L.I.Dorman.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 149.

Brief note, substantially as follows, The passage, through an interplanetary ionized medium, of solar corpuscular streams carrying frozen-in magnetic fields is considered. It is shown that an originally laminar stream with a regular magnetic field should, as result of interaction with the interplanetary medium, become turbulent at a definite distance from the sun (of the order of the earth's orbit), which distance is a function of the velocity of the stream, it density and the intensity of the magnetic field frozen in it, and also of the density of the interplanetary medium. Also considered is th effect of streams with different possible structure on the intensity of the primary cosmic radiation. In particular, it is shown that if a stream with a turbulent field, which was originally regular, envelopes the earth, the Morrison mechanism should be operative. In an expanding turbulent stream there will also operate the Parker mechanism (solar wind) and the Singer mechanism (deceleration of particles by the anti-Fermi mechanism). An evaluation is given of the effectiveness of these mechanisms. Corpuscular streams push out the magnetic field of the galactic spiral and for a cavity which is free of this field (the Davis hypothesis). The dimensions of the cavity are calculated with allowance made for interaction of streams (carrying frozen-in magnetic fields) with the interplanetary medium. The action of the interplanetary medium on the structure of the stream is assessed. The properties of the magnetic trap in the stream and the structure of the magnetic field in it are determined. The problems under discussion are considered in close association with the general problem of the modulation of cosmic radiation in the solar system and in the immediate vicinity of the earth.

523.77

10508 SOLAR EMISSION LINES IN THE EXTREME ULTRAVIOLET. T.Violett and W.A.Rense.

Astrophys. J., Vol. 130, No. 3, 954-60 (Nov., 1959).

Measurements of rocket spectrograms obtained from Aerobee-Hi flights on June 4, 1958, and March 30, 1959, have yielded wavelengths of about 150 solar ultraviolet emission lines in the range between 1216 (HLα) and 83.9 A. Estimates of the intensity of the He II 303.8 A line were made. Measured wavelengths corrected for systematic errors and, in some cases, identifications of the lines are given.

523.77

10509 SOLAR LIMB DARKENING NEAR λ 6563 FROM 0.9 TO 1.00R. R.B.Dunn.

Astrophys. J., Vol. 130, No. 3, 972-84 (Nov., 1959).

A curve of solar limb darkening from 0.9 to 1.00 radius has been obtained in the continuum near Hα. The observation has been corrected for the instrumental profile of a point distribution of light.

523.77

10510 THE SOLAR LIMB INTENSITY PROFILE. J.B.Rogerson, Jr.

Astrophys. J., Vol. 130, No. 3, 985-90 (Nov., 1959).

A selected photograph of the solar limb, taken by a balloon-borne telescope, has been analysed to give the intensity distribution of the solar limb at λ 5400 A. This work extends existing limb-darkening measurements to within about 1 second of arc of the limb.

523.77

10511 THE WAVELENGTH DISPACEMENTS OF SOME INFRA-RED LINES BETWEEN LIMB AND CENTER OF THE SUN. II. L.Herzberg.

Canad. J. Phys., Vol. 38, No. 6, 853-65 (June, 1960).

For Pt I see Abstr. 7559 of 1957. The differences between the wavelengths at the solar limb and at the centre of the disk have been measured for lines of Fe, I, Si, Iand VaII in the λ8500 A and λ8900 A regions of the spectrum. The values of the limb—centre displacements (in km/sec) of the Fe I lines in the two wavelength regions studied are found to be the same as those obtained by Adam for neutral metal lines at λ6100 A. The limb—centre displacements of the Si I lines are similar in magnitude and in the same direction as those of Fe I. Although the data are insufficient to decide the question as to term dependence of the solar wavelength shifts of Si I, any relation to the shifts observed in a laboratory light source can be excluded. For the Ca II lines at λ8500 A and λ8900 A, corresponding to two different transitions, the limb—centre displacements differ from each other both in magnitude and in direction. The limb—centre displacements of the λ8900 A Ca II lines are smaller than those of the Fe I lines, while of those the λ8500 A Ca II lines are significantly larger and in direction opposite to those observed for lines of Fe I. Where possible, comparison has been made between the wavelengths observed at limb and centre of the disk and the solar wavelengths predicted by General Relativity Theory. In all cases the wavelengths at the limb were found to be closer to the predicted values than the wavelengths measured at the centre of the disk. While for the lines of Fe I the predicted solar wavelengths and those observed near the limb (r/R = 0.982) are in good agreement, the wavelengths close to the solar limb of the λ8500 A Ca II lines are found to be significantly larger than those predicted by relativity theory.

523.8

10512 EXISTENCE OF NET ELECTRIC CHARGES ON STARS. V.A.Bailey.

Nature (London), Vol. 186, 508-10 (May 14, 1960).

It is suggested that a solar-type star of mass M carries a charge $-\beta G^{1/2}M$, where β is a pure number of order 0.03. This hypothesis could account for the magnetization of the Earth, the outer Van Allen belt of radiation, the maximum energy of primary cosmic ray particles, the Sun's north polar magnetic field vector and Blackett's relation between stellar magnetic moments and angular momenta. It is also suggested that the hypothesis would provide qualitative explanations for a number of other phenomena such as radio emission associated with solar flares, novae and colliding galaxies. Stellar charge might be a consequence of a five dimensional unified field theory, or might arise from thermonuclear processes under the assumption that a neutrino carries a small positive charge.

R.A.Newing

523.8

10513 ON THE PROBLEM OF THE MECHANISM OF THE ORIGIN OF STARS IN STELLAR ASSOCIATIONS. V.A.Ambartsumian.

Rev. mod. Phys., Vol. 30, No. 3, 944-6, 946-8 (July, 1958).

Observational data concerning large gaseous clouds are discussed and the possibility is suggested of the joint, but not quite simultaneous, formation of stars and nebulae as the result of a single process. Attention is drawn to the significance of stellar chains in the problem of the mechanism of star formation.

R.A.Newing

523.8

10514 POSSIBLE MECHANISMS OF SINGLE AND MULTIPLE STAR FORMATION. G.J.Odgers and R.W.Stewart.

Rev. mod. Phys., Vol. 30, No. 3, 1017-18, 1018-19 (July, 1958).

A qualitative discussion of the possibility of star formation from the gravitational collapse of HI clouds is based on dimensional considerations.

R.A.Newing

523.85

10515 STATISTICAL STUDY OF GLOBULES PROJECTED ON STELLAR CLOUDS. D.A.Rojkovsky.

Rev. mod. Phys., Vol. 30, No. 3, 949-50 (July, 1958).

Small deviations from the expected Laplace distribution of the number of stars in a given area of a star field containing absorbing matter, are used to estimate the number and mean absorbing capacity of the globules supposed responsible for such deviations.

G.A.Chisnall

523.85

10516 STAR CHAINS AND DARK FILAMENTS IN GALACTIC NEBULAE. V.G.Fessenkov.

Rev. mod. Phys., Vol. 30, No. 3, 951-2 (July, 1958).

The physical reality of star chains is questioned by searching for similar inhomogeneities in artificial "star" fields. However, it is noted that the stars of an actual chain are usually of the same colour and are often associated with dark filaments. The density of dust in those in the region of McDonald 12 in Cygnus may attain 10^{-22} g cm^{-3}.

G.A.Chisnall

523.85

10517 MICROSTRUCTURE OF THE GALACTIC MAGNETIC FIELD. K.Serkowski.

Rev. mod. Phys., Vol. 30, No. 3, 952-3, 954 (July, 1958).

A discussion of the polarization of a group of stars around the Double Cluster in Perseus leads to a value for the galactic magnetic field strength of $B = 5 \times 10^{-6}$ gauss. By considering also the reddening effect and data from the Stock Cluster in Perseus it is concluded that polarization is produced mainly in the H II regions but reddening in the H I regions.

G.A.Chisnall

523.85

10518 COMPARISON OF GAS AND RADIATION PRESSURE IN THE PROBLEMS OF THE DYNAMICS OF PLANETARY NEBULAE. H.Zanstra.

Rev. mod. Phys., Vol. 30, No. 3, 1030-3 (July, 1958).

It is shown that gas pressure is predominant and can lead to expansion velocities of the same order as those observed, but that the optical depth in the Lyman continuum may be a major factor in determining the structure of ring-nebulae.

P.A.Young

523.85

10519 LOCAL DENSITY VARIATIONS IN PLANETARY NEBULAE.

M.J.Seaton.

Rev. mod. Phys., Vol. 30, No. 3, 1034 (July, 1958).

A summary article quoting results obtained in various references. A table is given of densities in five planetaries, calculated from surface brightnesses and from deactivation rates; the anomalous results from the O II 3729/3726 ratio are dealt with separately, whilst the other differences are attributed to local condensations.

P.A.Young

523.85

10520 INTERNAL KINEMATICS OF THE PLANETARY NEBULAE.

O.C.Wilson.

Rev. mod. Phys., Vol. 30, No. 3, 1025-9 (July, 1958).

It is shown that a study of the asymmetries of line images taken with multiple-slit spectrographs can yield information about the internal motions of the planetary nebulae; the basic assumption being that hydrogen and helium emission occur throughout the nebula, whereas that of the other elements, principally the forbidden lines, depend on the free electron supply produced by ionization of the abundant hydrogen and helium. The results obtained support the hypothesis, that for nebulae with ellipsoidal shells, their shape is due to an initial ejection of matter with velocity distribution varying with angle, subject since then to disruption by Lyman-α radiation.

P.A.Young

523.85

10521 INTERNAL MOTIONS IN THE ORION NEBULA.

G.Münch.

Rev. mod. Phys., Vol. 30, No. 3, 1035-9, 1039-41 (July, 1958).

A measurement of radial velocities has been made using a multislit technique, with an accuracy of 0.5 km/s in velocity and of about 0.75'' in position. A study of the linewidths shows that the thermal and turbulent components of the motions are about equal (8 km/s). The correlation between velocities at different points in the nebula is shown to agree with von Hoerner's earlier work (see Abstr. 1394 of 1952) but the improved accuracy of the new results demonstrate that his predictions, using the Kolmogoroff theory, of the effective optical depth of the nebula, are untenable; that is to say, he estimated a value of 12 pc^{-1} whereas the observations on colour excesses of stars embedded in the nebula lead to a value of 5 pc^{-1}, for which value the theoretical correlation between velocity difference at points in the nebula, separated by Λ, would vary according to $\Lambda^{5/6}$ whilst the observed variation is more nearly as $\Lambda^{1/3}$; it is concluded that the theory of incompressible turbulence fails to account for the state of motion in the nebula. Further consideration is then given to the line-doubling and its positional variation in the nebula, the complete lack of any relationship with the geometry of the nebula and exciting stars, and the different behaviour of the O II and O III lines is explained by the enclosure of pockets of cold gas within the expanding hot gases of the nebula. In the discussion of the paper further results on the correlation of brightness are presented.

P.A.Young

523.85

10522 KINEMATICS OF THE FILAMENTS IN THE CRAB NEBULA.

G.Münch.

Rev. mod. Phys., Vol. 30, No. 3, 1042-5, 1045-6 (July, 1958).

Discusses the close connection between the filaments and the magnetic field in the nebula, drawing attention to the facts that the kinetic energy of the electrons in the filaments is about equal to the magnetic energy and that the major-axis of the nebula is aligned with the galactic equator; thus both a dynamo origin of the field and the general galactic field are of importance.

P.A.Young

523.85

10523 ON THE NATURE OF THE EMISSION OF THE CRAB NEBULA.

I.S.Shklovsky.

Rev. mod. Phys., Vol. 30, No. 3, 1047 (July, 1958).

The emission by "wisps" in the nebula, is attributed to local fluctuations in the magnetic field, a two or threefold increase of field strength leading to a hundred-fold increase in the energy radiated by relativistic electrons moving through the nebula.

P.A.Young

523.85

10524 CYGNUS LOOP AND SOME RELATED NEBULOSITIES.

R.Minkowski.

Rev. mod. Phys., Vol. 30, No. 3, 1048-51, 1051-2 (July, 1958).

Measurements have been made of radial velocities and of relative intensities of lines, from which it is concluded that the emission is due to collisional excitation and that the Cygnus and similar nebulae originate from type II supernovae. In the discussion following the paper attention is drawn to possible errors when using Hα/Hβ ratios owing to neglect of the degeneracy of the hydrogen levels.

P.A.Young

523.85

10525 BRIGHT RIMS IN DIFFUSE NEBULAE.

S.R.Pottasch.

Rev. Mod. Phys., Vol. 30, No. 3, 1053-8 (July, 1958).

The bright rims observed in diffuse nebulae are measured for a number of cases, and values of the shape, orientation, and distance from the exciting star are correlated. Rayleigh—Taylor instabilities are shown to be inconsistent with the observations. An interpretation is suggested based on the interaction of ionizing radiation with a cloud of gas.

A.H.Gabriel

523.87

10526 NEUTRON STAR MODELS.

A.G.W.Cameron.

Astrophys. J., Vol. 130, No. 3, 884-94 (Nov., 1959).

Previous models of neutron stars were constructed with the assumption that the equation of state of a neutron gas is that of non-interacting Fermi gas. Such models have a maximum observable mass of about 0.7 solar mass. In fact, the potential energy of a neutron gas depends on the density; this introduces additional terms into the equation of state. A revised equation of state has been derived which makes use of a mean nuclear potential given by Skyrme Twenty neutron star models have been constructed by integrating the general relativistic equations of hydrostatic equilibrium of the neutron gas. The results show that there is an upper limit to the observable mass of about 2 solar masses; the corresponding upper limit to the proper mass is about 3 solar masses. There is a lower limit to each of these masses of about 0.05 solar mass, below which the neutron star is unstable against transformation into an iron star. The radii of these neutron stars lie in the range 7-9 km. A qualitativ discussion of the effects of transformation of neutrons into hyperons at very high densities is given.

523.87

10527 THE INFLUENCE OF THE ABUNDANCE OF HELIUM ON THE CONTINUOUS SPECTRA OF B STARS.

C.Chadeau.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2130-1 (March 21, 1960). In French.

A graph is shown of the variation of the Balmer (λ3647) and He I (λ3422) discontinuities as functions of the helium/helium + hydrogen ratio; otherwise, variation of this ratio has little effect on the continuum. Details of the calculations are not given, only the method and results.

P.A.Young

523.87 : 537.56

COMPUTING THE MEAN RANGE OF RADIATION IN IONIZED GASES AT HIGH TEMPERATURES. See Abstr. 10915

523.877

10528 GIANT STARS WITH SHELL SOURCES OF C—N and p—p REACTIONS.

C.Hayashi.

Progr. theor. Phys., Vol. 17, No. 6, 747-43 (June, 1957).

Structures of giant stars of population II producing energy in the C—N shell source are studied taking account of the contribution of th ion pressure in the partially degenerate isothermal core and also of the exact fitting of the radiative region to the convective one. Furthe it is found that pure hydrogen stars producing energy in the p—p shel source can also explain the giant branch of population II if the effect of the ion pressure is included in the core.

523.877 : 537.56

THE ELECTRON TEMPERATURE OF VARIABLE STARS. See Abstr. 9042

525

10529 THE NEW REGIME OF THE EARTH'S ROTATION ESTABLISHED IN JULY, 1959.

É.Schatzman.

C.R. Acad. Sci., (Paris), Vol. 250, No. 15, 2680-2 (April 11, 1960). In French.

An explanation for the change in period is sought in the transference of angular momentum from an intense solar stream of protons, captured by the earth's magnetic field at a distance possibly as great as 150 times the radius of the earth. G.A.Chisnall

525

10530 SATELLITE PERTURBATIONS FROM EXTRA-TERRESTRIAL GRAVITATION AND RADIATION PRESSURE.

F.T.Geyling.

J. Franklin Inst., Vol. 269, No. 5, 375-407 (May, 1960).

The equations of motion of an artificial satellite are written in terms of displacement components relative to the unperturbed, elliptic orbit. A moving system of coordinates is used which consists of an orthogonal triad whose origin is always located at the nominal satellite position on the elliptic orbit. This approach differs from the conventional one by way of Lagrange's planetary equations in that the primary results are expressions for the satellite position rather than the osculating orbit elements, which seems an advantage for practical applications. Calculations are carried out for the effects of perturbations in the initial conditions of satellite motion and perturbations due to oblateness, lunar and solar gravitation, and solar radiation pressure. In the numerical examples, special attention is devoted to the performance of a thin mylar balloon acting as a passive communication satellite.

525

10531 ROCKET ASTRONOMY.

H.Friedman.

Sci. American, Vol. 200, No. 6, 52-9 (June, 1959).

General article on the use of rockets to carry instruments above the ultraviolet-absorbing layers of the atmosphere, and the type of information gained in this way.

525

10532 ROCKET ASTRONOMY.

H.Friedman.

J. geophys. Res., Vol. 64, No. 11, 1751-63 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr. 8521 of 1960). Astronomical observations with rocket-borne telescopes and spectrographs are of the greatest value to research for they enable results to be obtained that are completely free from the effects of terrestrial atmospheric absorption. This is particularly so when observing in the ultraviolet at wavelengths below 3000 A. It is unnecessary to go deep into outer space since the first 300 km of atmosphere contains almost all the important absorbing gases. A detailed description is given of rocket-borne spectrographic equipment with which important new results have already been obtained. D.R.Barber

525

10533 ASTRONOMY FROM SATELLITES AND SPACE VEHICLES.

L.Goldberg.

J. geophys. Res., Vol. 64, No. 11, 1765-78 (Nov., 1959).

Exploration of Space Symposium, Washington, 1959 (see Abstr 8521 of 1960). A comprehensive review of what may be achieved by means of controlled astronomical experiments from instrumented satellites and space vehicles. Some of the recent rocket experiments are mentioned, e.g., Friedman's ultraviolet sky survey resulting in the unexpected discovery of intense emission over extensive areas of sky at wavelengths ~ 1300 A. D.R.Barber

525 : 621.396.946

10534 ASTRONOMICAL OBSERVATION WITH THE AID OF ARTIFICIAL SATELLITES.

F.Hoyle.

Proc. Roy. Soc. A., Vol. 253, 492-3 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr. 8520 of 1960). A review of present restrictions to conventional groundbased astronomical observations. These are: (1) the atmospheric window is transparent only within the range 3000 - 8000 A (except for the second "radio-window"); (2) the optical image at the telescope, or camera, is unsteady due to atmospheric turbulence; (3) there is much unwanted light in the "background" illumination due to nocturnal luminescence of the upper atmosphere. Observations with moderate-sized instruments carried by artificial satellites will overcome these serious disadvantages, and so open up exciting new possibilities. D.R.Barber

525

10535 THREE-DIMENSIONAL INTERPLANETARY TRAJECTORIES.

A.B.Mickelwait, E.H.Tompkins, Jr and R.A.Park.

.R.E. Trans Military Electronics, Vol. MIL-3, No. 4, 149-59 (Oct., 1959).

Developments in guided missiles and related scientific areas have reached a state where ballistic flights to the planets Venus and Mars are feasible and imminent with existing equipment. This paper discusses considerations involved in making actual ballistic flight to Venus. Conventional two-dimensional analysis is compared to the actual three-dimensional case. Burnout conditions required to minimize the problems of guidance, payload, range safety, booster aerodynamics, midcourse guidance, and capture are established. Problems relating to launch times, launch latitude, and interplanetary communications are also discussed.

525

10536 SCIENTIFIC OBJECTIVES OF THE ABLE-3 PROGRAM.

I.R.E. Trans Military Electronics, Vol. MIL-3, No. 4, 129-43 (Oct., 1959).

The purpose of the Able-3 programme is to place a scientific observatory in a highly elliptic satellite orbit. A scintillation counter, ion chamber, Geiger counter, and proportional counter telescope in the payload permit comprehensive mapping of corpuscular radiation over a large volume of the geomagnetic region, including the Van Allen radiation belts. Simultaneously, the fundamental static quantities, electron density, and vector magnetic intensity may be measured. A v.l.f. experiment is included to measure upper-atmosphere v.l.f. noise and to study the propagation characteristic of v.l.f. between the ground and the satellite. A radio scintillation experiment using radio telescopes will measure the effects of ionospheric irregularities on amplitude and phase. Micrometeorite detection equipment in the payload provides a two-point momentum spectrum of micrometeorites encountered, and an image scanner is included to examine reflection characteristics of the earth. This satellite was launched on August 7, 1959 and has been designated Explorer VI. Paper prepared by the Applied Physics Dept., Space Technology Laboratories, Inc.

525

10537 APPLICATION OF HANSEN'S THEORY TO THE MOTION OF AN ARTIFICIAL SATELLITE IN THE GRAVITATIONAL FIELD OF THE EARTH.

P.Musen.

J. geophys. Res., Vol. 64, No. 12, 2271-79 (Dec., 1959).

Permits the easy inclusion of any gravitational term. The theory is adaptable to the use of large computing machines and is valid for zonal harmonics of all orders of the earth's gravitational field. The computations can be carried out to any desired order compatible with the accuracy of the geodetic parameters.

525

10538 CHARGE AND MAGNETIC FIELD INTERACTION WITH SATELLITES.

D.B.Beard and F.S.Johnson.

J. geophys. Res., Vol. 65, No. 1, 1-8 (Jan., 1960).

The interaction of a satellite with the magnetic field of the earth and the ionized medium through which it is moving has been investigated. Owing to the differing incident velocities of ions and electrons and therefore differing incident flux intensities, a negative potential will be induced on the satellite, but it is smaller than has previously been believed. Satellite motion across the magnetic lines of the earth will induce a voltage on the satellite of as much as 0.2 V/m of satellite size, and this may affect the interpretation of measurements of satellite potential. The magnetic drag resulting from the induced currents is proportional to the cube of the satellite dimensions and may exceed the mass drag for satellites larger than 50 m in diameter; this can occur only above 1200 km altitude, where the charge density exceeds the neutral density. Thus the magnetically induced current is an insignificant cause of drag. Although some useful power can be extracted from the induced current, it is not a very promising source of auxiliary power for presently conceived vehicles.

525

10539 SATELLITE ORBITS IN AN OBLATE ATMOSPHERE.

D.G.Parkyn.

J. geophys. Res., Vol. 65, No. 1, 9-18 (Jan., 1960).

Density values of the upper atmosphere derived from the rate of development of the orbits of earth satellites suffer from errors introduced by uncertainties in the determination of the mean drag cross-section. As a result it is difficult or impossible to detect minor variations in the density such as, for example, its latitude dependence. An analysis is developed which circumvents this difficulty by considering the behaviour of a dynamically simple parameter — the square of the product of the semimajor axis and the eccentricity.

Examples from published orbital data are discussed, showing clearly the presence of a latitude dependence, and estimates of the ratio of polar to equatorial density are deduced.

525 : 551.5

10540 OBSERVATIONS OF IONIZATION INDUCED BY ARTIFICIAL EARTH SATELLITES.
J.D.Kraus, R.C.Higgy, D.J.Scheer and W.R.Crone.
Nature (London), Vol. 185, 520-1(Feb. 20, 1960).

Enhancements of the strength of continuous wave signals from the station WWV were found at the times of approach of Sputnik III. The enhancements were greatest as the satellite passed through the auroral zone. Echoes were obtained from moving regions near the path of the satellite which were postulated to be caused by ionized clouds scattered by the satellite. R.D.Davies

525 : 551.5 : 621.317.7

10541 SELF-CONTAINED MEASURING EQUIPMENT FOR [UPPER ATMOSPHERE] ELECTRON DENSITY AND IONIC MASS SPECTRUM. J.Sayers.
Proc. Roy. Soc. A, Vol. 253, 522-5 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). Two experiments are described which, although designed in the first instance for rocket installation, have new features which may make them useful, in a modified form, for satellite instrumentation. The first concerns the plasma dielectric method of measuring upper-atmosphere electron densities. The equipment described represents the first attempt at the measurement of local electron density by detecting changes in the dielectric constant using instruments self-contained in the vehicle. The second concerns an automatic mass spectrometer for the analysis of ionic masses in the upper atmosphere. The spectrometer has a very large aperture (1000 cm^2) and is thus expected to be able to detect small proportions of certain ion types in the main distribution which may play an important part in ionic processes. C.F.Barnaby

525.5 : 537.56

WAKE OF A SATELLITE TRAVERSING THE IONOSPHERE. See Abstr. 9023

525 : 621.317.7

10542 SOME TECHNIQUES OF PHYSICAL MEASUREMENT [IN SPACE RESEARCH]. R.L.F.Boyd.
Proc. Roy. Soc. A, Vol. 253, 516-22 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). The problem of physical measurement in a celestial laboratory is discussed with particular reference to the possible uses of the Langmuir probe in satellites. The use which has been made of the space vehicle's proper motion in some techniques of physical measurement is described. The analysis of the energy distribution of particles and the mass analysis of ions using a Langmuir probe are considered in detail. C.F.Barnaby

525 : 621.396.946

10543 RADIO ASTRONOMICAL MEASUREMENTS FROM EARTH SATELLITES. A.C.B.Lovell.
Proc. Roy. Soc. A., Vol. 253, 494-500 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (See Abstr. 8520 of 1960). Radio observations from satellites will overcome the difficulties experienced on Earth arising from scintillations over a wide range of frequencies. Measurements of extraterrestrial radiation at frequencies below 30 Mc/s will give valuable information about the spectrum of radio sources and the nature of galactic radio emission. The non-thermal emissions from Jupiter, low-frequency emissions from the sun, and the flux of micrometeorites can also be investigated. R.D.Davies

525 : 550.3

EXPLORER VI MAGNETOMETER DATA. See Abstr. 10394

525 : 621.396.946

10544 RADIO COMMUNICATION WITH A LUNAR PROBE. W.T.Blackband.
Proc. Roy. Soc. A, Vol. 253, 511-15 (Dec. 29, 1959).

Space Research Discussion, London, 1958 (see Abstr. 8520 of 1960). Communication has to be made in the presence of background extrasolar radiation, and of receiver noise. The signal-to-noise ratio is calculated for typical probes to the moon and Mars. R.D.Davies

529

10545 HIGH FREQUENCY CHRONOMETRY. B.Decaux.
Cahiers de Phys., Vol. 13, 12-16 (Jan., 1959). In French.

A review is given of current high precision frequency standards, and the caesium atomic beam and the ammonia maser standards are described in more detail. The usefulness of time standards accurate to better than 1 : 10^{10} is discussed with particular reference to the measurement of relativistic effects such as the gravitational red shift and experiments on the "clock paradox" problem. J.M.Baker

529

10546 FREQUENCY MEASUREMENT OF STANDARD FREQUENCY TRANSMISSIONS. S.N.Kalra.
Canad. J. Phys., Vol. 38, No. 5, 713 (May, 1960).

A short note tabulating observations comparing radio transmissions of frequency.

529.538.56 : 621.373.5 : 621.317.76

10547 FREQUENCY VARIATIONS OF QUARTZ OSCILLATORS AND THE EARTH'S ROTATION IN TERMS OF THE N.P.L. CAESIUM STANDARD.
L.Essen, J.V.L.Parry and J.McA.Steele.
Proc. Instn Elect. Engrs, Paper 3002 M, publ. Aug., 1959 (Vol. 107B, 229-32, 232-4, May, 1960).

Republication, with discussion, of the paper already abstracted as Abstr. 21 of 1960.

PHYSICS

GENERAL

53

10548 R.A.A.G. MEMOIRS OF THE BASIC PROBLEMS IN ENGINEERING AND PHYSICAL SCIENCES BY MEANS OF GEOMETRY. Vol. II.
Edited by K.Kondo.
Tokyo (1958) Gakujutsu Bunken Fukyu-kai [Association for Science Documents Information], 589 pp.

This volume is published for the Research Association of Applied Geometry (R.A.A.G.), University of Tokyo, and contains 28 memoirs, divided into 8 divisions covering applications in different fields.

53

10549 ON TECHNIQUES FOR LINEAR AND PARABOLIC SMOOTHING OF OBSERVED DATA. G.Ohl.
Arch. elekt. Übertragung, Vol. 13, No. 12, 530-2 (Dec., 1959). In German.

Fitting the linear and quadratic regressions

$$Y_1 = a + bx; \quad Y_2 = a + bx + cx^2$$

respectively, using techniques of repeated summation, is described. The values of x are assumed to be known exactly; each value of y is supposed to have the same variability. Explicit formulae are obtained for the case when the x's are equally spaced. N.L.Johnson

53

10550 RELATION BETWEEN THE GRAVITATIONAL CONSTANT, THE CHARGE TO MASS RATIO OF THE ELECTRON, AND THE FINE STRUCTURE CONSTANT. I.G.Ivanter.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1940 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9) No. 6, 1380 (Dec., 1959).

Claims that the following numerical relation exists:

$$\frac{1}{G}\left(\frac{e}{m}\right)^2 = \left(\frac{4\pi}{3}\right)\hbar c/2e^2$$

This relation is extremely sensitive to the value of the fine structure constant ($\alpha = e^2/\hbar c$); nevertheless, the accuracy is 1%.

GRAVITATION . RELATIVITY

530.12

10551 MATHEMATICAL THEORY OF EULER'S ANGLES IN SPACE—TIME.

F.Halbwachs, P.Hillion and J.P.Vigier.
Ann. Inst. Poincaré, Vol. 16, No. 3, 115-234 (1959). In French.

The classical concept of Euler's angles in three-dimensional Euclidean space is generalized to the space—time of special relativity by the introduction of three complex angles and their conjugates. The analogy is extended to include the Lorentz group using rotation operators corresponding to complex rotations around the self-dual bivectors. The behaviour of the proper functions of these operators under the operations C, P and T is examined. T.R.Carson

530.12

10552 CLASSICAL RADIATION FROM A UNIFORMLY ACCELERATED CHARGE.

T.Fulton and F.Rohrlich.
Ann. Phys. (New York), Vol. 9, No. 4, 499-517 (April, 1960).

The old and much-debated question, whether a charge in uniform acceleration radiates, is discussed in detail and its implications are pointed out. Many contradictory statements in the literature are analysed and those answers which can be given on the basis of the standard classical Maxwell—Lorentz equations are presented. Although the questions that remain open are difficult and fundamental, some simple results can be proved: Contrary to claims in some standard sources (Pauli, von Laue), a charge in uniform acceleration does radiate. The radiation rate is finite, invariant, and constant in time in the instantaneous rest system. There is no contradiction of this fact with either the principle of conservation of energy or the principle of equivalence. Finally, the group of conformal transformations is found to be not physically meaningful.

530.12

10553 ACTION AS A SPACE COORDINATE. X.

Yu.B.Rumer.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1894-902 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1348-53 (Dec., 1959).

For previous parts, see "Investigation in five-optics", Moscow: State Technical and Theoretical Press (1956). The difficulties encountered in five-optics in formulation of the spinor equations are surmounted. It is shown that the requirement of invariance with respect to physically permissible transformations leads to correct spinor equations. The requirement of physical admissibility separates subgroups of general transformations of the four-dimensional space—time and gauge transformations from the general transformations from the general transformation group of five-dimensional space. Restriction of the group of permissible transformations does in no means signify that the five-dimensional conception is not valid in principle. The most important feature of the five-dimensional theory is the periodic dependence (with period h) of the fields on the action coordinate. This fact and its consequences cannot be reduced to a simple unification of the four-coordinate point-transformation group with the gauge-transformation group. Another essentially five-dimensional effect is the existence of the scalar χ-field whose appearance in the theory of the field of a charged material particle yields formulae that differ from those of present-day gravitation theory.

530.12 : 539.11

10554 THEORY OF SPINORS IN RIEMANN SPACE.

E.Schmutzer.
Z.Naturforsch., Vol. 15a, No. 4, 355-62(April, 1960). In German.

The Infeld—van der Waerden theory of spinors is extended by using the method of base vectors. The spinorial geometry is developed in analogy to the tensorial geometry and important identities and relationships are obtained for the curved spinor-space. It is shown that even if the covariant derivative of the metric spinor vanishes, the geometry leads necessarily to the existence of an antisymmetric tensor which may be associated with the electromagnetic field. P.Roman

530.12

10555 UNCERTAINTY PRINCIPLE AND RELATIVITY.

B.Kivel.
Amer. J. Phys., Vol. 28, No. 4, 404-5 (April, 1960).

The "cannot measure" postulates of quantum mechanics and relativity are held to be related in a fundamental way and provide a basis for a possible unification of the two theories. T.R.Carson

530.12

10556 ON THE GRAVITATIONAL INTERACTION ON THE QUANTUM LEVEL.

O.Costa de Beauregard.
C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2521-3 (April 4, 1960). In French.

530.12

10557 ON THE QUESTION OF THE RELATIVISTIC METRIC ON A ROTATING DISC.

A.Metz.
Cahiers de Phys., Vol. 13, 196-200 (May, 1959). In French.

530.12

10558 A NONLINEAR VACUUM EFFECT IN GRAVITATION THEORY.

N.V.Mitskevich.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1207-11 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol, 36(9), No. 4, 859-61 (Oct., 1959).

Second-quantization theory leads to a new interaction between gravitons through the virtual quanta of other fields. For the case of a scalar field in a slowly changing metric, a vacuum cosmological term arises, and can be obtained using Schwinger's method. This can be used to evaluate an additional scattering of gravitons by a Schwarzschild field in a scalar particle vacuum. For low-energy gravitons, the effect is comparable with the nonlinear effect in the classical theory.

530.12

10559 LINEAR THEORIES OF GRAVITATION.

V.I.Pustovoit.
Zh. eksper. teor. Fiz., Vol. 37(10), No. 3, 870-1 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37, No. 3(9), 619-20 (March, 1960).

Modifications of Kepler's laws for satellite motion arising from the Birkhoff, and the Belinfante—Swihart, linear theories are compared with corresponding results in general relativity. The effects of rotation of the central body in the three theories are also compared. R.A.Newing

530.12

10560 TAKING ACCOUNT OF THE GRAVITATIONAL ENERGY.

D.D.Ivanenko and N.V.Mitskevich.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 868-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 618-19 (March, 1960).

The conserved quantities derived from the invariance properties of Lagrange functions for fields (Abstr. 8572 of 1958) are shown to be closely related to Møller's energy density and to provide a uniform definition of physical quantities for all fields. The total energy of a system of fields, allowing for gravitation, may be derived from an energy—momentum "quasi-tensor". R.A.Newing

530.12 : 539.2 : 538.27

10561 UPPER LIMIT FOR THE ANISOTROPY OF INERTIAL MASS FROM NUCLEAR RESONANCE EXPERIMENTS.

V.W.Hughes, H.G.Robinson and V.Beltran-Lopez.
Phys. Rev. Letters, Vol. 4, No. 7, 342-4 (April 1, 1960).

The application of Mach's principle suggests the possibility that, as the distribution of matter in our galaxy is not isotropic, the mass of a particle on earth may depend on the direction of acceleration of the particle with respect to the direction of the centre of the galaxy. Cocconi and Salpeter (Abstr. 7470 of 1960), suggest that there should be a contribution to the binding energy of a particle in a Coulomb field $\Delta E = (\Delta m/m)\,\overline{T}\,P_2\,(\cos\theta)$, where $\overline{T}$ is the average kinetic energy of the particle, $P_2\,(\cos\theta)$ the Legendre polynomial of order 2 and θ the angle between the particle acceleration and the direction of the galactic centre. Δm is the anisotropic and m the isotropic part of the mass. Two experiments are described in which an attempt was made to measure this effect. In the first, the frequency of the Zeeman transition $M_J = +3/2 \rightarrow M_J = +1/2$ with $M_I = 3/2$ in the ${}^2P_{3/2}$ state of Cl^{35} was determined as a function of angle between the magnetic field and the direction of the galactic centre (varying as a result of the earth's rotation). No effect was observed, and an upper limit of 10^{-10} placed on $\Delta m/m$. In another, more sensitive experiment, an attempt was made to detect splitting of the nuclear magnetic resonance line resulting from transitions between levels of different M_I for the $I = 3/2$ ground state of Li^7, as a function of the same angle. Only a single line was observed as would be expected if there were no mass anisotropy and the limit obtained was $\Delta m/m \leq 10^{-20}$. R.E.Meads

530.12

10562 GRAVITATIONAL FIELD WITH INDUCTION.
L.Bel.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2137-9 (March 21, 1960). In French.

A theory of the gravitational field with induction is defined and analogies are drawn between this phenomenon and that of electromagnetic induction. T.R.Carson

530.12

10563 QUANTIZATION OF THE GRAVITATIONAL FIELD.
A.Lichnerowicz.

C.R. Acad. Sci.(Paris), Vol. 250, No. 19, 3122-4 (May 9, 1960). In French.

The author's method of antisymmetric propagators is used to quantize the field generated by variation of the metric tensor of an Einstein space. R.A.Newing

530.12 : 539.11

QUANTIZED MESON FIELD IN A CLASSICAL GRAVITATIONAL FIELD. See Abstr. 9287

530.12

10564 THE HYPOTHESIS OF THE GRAVITATIONAL EFFECT OF SPIN.
O.Costa de Beauregard.

Cahiers de Phys., Vol.12, 407-15 (Nov., 1958). In French.

A restatement of the author's theory (Abstr. 20 of 1959). The transverse energy-momentum vector is represented in terms of a surface source distribution, and the possible macroscopic manifestation of the gravitational spin effect is discussed. It is suggested that an experimental detection of the effect might be possible on account of the spin density associated with the magnetization of a ferromagnetic material. R.A.Newing

530.12

10565 GRAVITATIONAL INSTABILITY IN PLANE ROTATING SYSTEMS WITH AXIAL SYMMETRY.
V.S.Safronov.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 1, 53-6 (Jan. 1, 1960). In Russian.

An instability condition which depends on λ, the wavelength of the perturbations, and H, the thickness of the layer is obtained for such systems when subject to radial sinusoidal perturbations. When the motion is dominated by a central mass (e.g. the solar system, the inner part of the Galaxy) the condition leads to a critical density which is a minimum for $\lambda = 8H$. The minimum value is 6 times that obtained by Bel and Schatzman [Rev. mod. Phys., Vol. 30, No. 3, 1015 (July, 1958)] for the 2-dimensional case and is larger than that of Chandrasekhar (Abstr. 4979 of 1957). G.A.Chisnall

530.12

10566 INVARIANT COMMUTATORS FOR THE QUANTIZED GRAVITATIONAL FIELD.
B.S.DeWitt.

Phys. Rev. Letters, Vol. 4, No. 6, 317-20 (March 15, 1960).

The question of the suitability of canonical procedures in the problem of the union of the general theory of relativity and quantum theory is raised. It is suggested, by obtaining without their aid, an explicit covariant expression for the commutators of the theory, that it may be possible to avoid them entirely. T.R.Carson

530.12

10567 SPHERICAL GRAVITATIONAL WAVES.
I.Robinson and A Trautman.

Phys. Rev. Letters, Vol. 4, No. 8, 431-2 (April 15, 1960).

Class of solutions to Einstein's gravitational equations for empty space, some of which represent a very simple kind of spherical radiation. J.K.Skwirzynski

530.12 : 538.3

10568 ELECTROMAGNETIC WAVES IN GRAVITATIONAL FIELDS.
J.Plebanski.

Phys. Rev., Vol. 118, No. 5, 1396-408 (June 1, 1960).

The scattering of plane electromagnetic waves by the gravitational field of an isolated physical system is studied. On the level of the geometrical optics approximation the general theory of light rays is formulated. In particular, the generalized formula for the Einstein reflection of light rays is obtained. On the level of the vectorial optics the problem of polarization is examined in detail. The formula obtained, describing a rotation of the plane of polarization due to the presence of the gravitational field, admits a direct geometrical interpretation. The theory is applied to the rotating body and a system of point masses. The physical results established concerning the asymptotic behaviour of the electromagnetic waves are independent of the coordinate system used in the computations.

530.12 : 539.14

10569 SEARCH FOR THE ANISOTROPY OF INERTIA USING THE MÖSSBAUER EFFECT IN Fe^{57}.
C.W.Sherwin, H.Frauenfelder, E.L.Garwin, E.Lüscher, S.Margulies and R.N.Peacock.

Phys. Rev. Letters, Vol. 4, No. 8, 399-401 (April 15, 1960).

A description is given of unsuccessful attempts to detect a broadening of the central resonance absorption line of Fe^{57} due to the local asymmetric distribution of matter. An upper limit of 10^{-13} is found for the relative energy shift, $\Delta E/E$, which,making tentative assumptions, implies that the relative local anisotropy of inertia, $\Delta M/M$, is less than 5×10^{-16}. E.A.Sanderson

530.12 : 539.12 : 539.14

10570 APPARENT WEIGHT OF PHOTONS.
R.V.Pound and G.A.Rebka, Jr.

Phys. Rev. Letters, Vol. 4, No. 7, 337-41 (April 1, 1960).

When emitted without nuclear recoil, the 14.4 keV γ-ray from the 0.1 μsec first excited state of Fe^{57} provides a very well defined frequency, the line having a fractional full width at half height of 1.13×10^{-12} for a carefully prepared source. This radiation has been used to detect the gravitational red-shift by measurement of the apparent shift of frequency between photons travelling vertically downwards through a height of 74 ft and being resonantly absorbed in a Fe^{57} foil, and photons travelling vertically upwards through the same height. The shift was measured by determining the difference in transmission of the absorber when the source was travelling towards and away from it with equal velocities. The source was oscillated using a ferroelectric or moving-coil transducer. Another absorber 3 ft from the source monitored the stability of the equipment. Corrections to the results were required for two effects: (a) A frequency shift due to temperature differences between source and absorber produced by second-order Doppler effect. A temperature difference of 1°C would produce a shift comparable with the gravitational effect. (b) A frequency shift characteristic of the combination of the source with any particular absorber. This could be accounted for also by second-order Doppler effect and differences of up to 11% in the Debye temperature of the lattice. This effect varied considerably using different absorbers and was at most ~5 times greater than the gravitational effect. After correction, the data yielded a net fractional shift $\delta\nu/\nu = -(5.13 \pm 0.51) \times 10^{-15}$ between the rising and falling photons compared with a theoretical prediction of -4.92×10^{-15}. R.E.Meads

530.12

10571 RELATIVISTIC KINEMATICS.
H.Arzeliès.

Trav. Inst. Sci. Chérifien Ser. Sci. phys., No. 1, xi + 230 pp. (1955). In French.

This first volume of a series by the author on relativity and gravitation is concerned with kinematics within the framework of the special theory. The book is notable for the numerous historical notes and extensive bibliography, and for a very careful discussion of the significance of physical measurements of length and duration. Relativistic theory is presented as a natural development of classical physics, and careful attention is given difficulties and paradoxes. There is a very full discussion of the problem of the rotating disc. The treatment throughout is in terms of 3-space and time, the four-dimensional development of the theory being summarized in a final chapter. R.A.Newing

530.12

10572 RELATIVISTIC DYNAMICS AND ITS APPLICATIONS. I. DYNAMICS OF A SLOWLY ACCELERATED PARTICLE APPLICATION TO INTERACTION PHENOMENA BETWEEN ELECTRIC CHARGES (RELATIVISTIC ELECTROMAGNETISM).
H.Arzeliès.

Trav. Inst. Sci. Chérifien Ser. Sci. phys., No. 2, xxi + 306 pp. (1957). In French.

The second volume of an exposition of the special theory. The historical notes and bibliography are again a special feature of the book, and the development continues in terms of 3-space and time. There is a very careful analysis of the concepts of force and of mass, and also an account of the Lagrange and Hamiltonian formulations of relativistic dynamics. The four-dimensional formulation is summarized. Relativistic dynamics, regarded as fundamental, is used to establish electromagnetism by the Lorentz transformation of the equations of electrostatics. The author's view point is illustrated by a discussion of the interaction between two moving charges without the explicit introduction of a magnetic field or of propagated action. The discussion is limited to the case of uniform or slowly accelerated motion. Various special problems in electrodynamics, such as that of unipolar induction, are discussed in a full and leisurely manner. R.A.Newing

530.12

10573 RELATIVISTIC DYNAMICS AND ITS APPLICATIONS. II. PROBLEMS OF MOTION IN THE DYNAMICS OF A SLOWLY ACCELERATED PARTICLE.

H.Arzeliès (in collaboration with R.Mendez).
Trav. Inst. Sci. Chérifien Ser. Sci. phys., No. 3, xxxiv + 451 pp. (1958). In French.

Detailed solutions are given for numerous special problems involving motion under the action of a uniform field, fields varying with position and central forces. The motion of a charged particle in uniform and in variable electric and/or magnetic fields is also considered in great detail. In many cases the solutions are complete with graphs illustrating the divergence of the results from the solutions of the corresponding problems in Newtonian mechanics. An account is given of the relativistic theory of rocket propulsion, and of elastic and non-elastic collisions. The coefficient $(1-v^2/c^2)^{1/2}$ and related quantities are tabulated in an appendix, and there are further additions to the historical notes and bibliography already given in the first two volumes of this series.
R.A.Newing

530.12

10574 REVISION OF THE THEORY OF RELATIVITY.

J.Palacios.
Rev. Acad. Ci. Madrid, Vol. 51, 21-101, 165-83, 245-92, 405-27(1957). (Spanish. English summaries).

The author believes, mainly because of the so-called clock paradox, that special relativity contains self-contradictions. He therefore proposes to drop the hypothesis that all inertial frames are equivalent, and to replace the restricted Lorentz transformation.
Mathematical Reviews

530.12

10575 THE MEASUREMENT OF TIME IN SPECIAL RELATIVITY.

S.J.Prokhovnik.
J. Roy. Soc. New S. Wales, Vol. 93, Pt 4, 141-6 (March, 1960).

Einstein's definition for measuring an observer's time of a distant event is examined in terms of its physical significance. The case of two receding observers at A and B, with similar clocks previously synchronized, is investigated. It is shown that A's time (according to Einstein's definition) of an event at B and B's clock reading coincident with it, are related according to the relevant Lorentz transformation, only if the two separated clocks have remained synchronous. The corresponding case of two approaching observers is also considered. It is suggested that the proposed interpretation of Einstein's definition is fully consistent with the principle of relativity and makes all inertial systems equivalent with regard to time, thus rendering unnecessary the concept of time dilatation.

530.12

10576 ARC LENGTHS IN SPECIAL RELATIVITY.

C.C.Macduffee.
Proc. Cambridge Phil. Soc., Vol. 56, Pt 2, 176-81 (April, 1960).

The clock paradox is shown to exist in the special theory of relativity as truly as it does in the general theory. It is proved, by examples in two and four dimensions, that in Minkowski space the extremals or geodesics represent relative maxima in contrast with the geodesics in Euclidean space. T.R.Carson

530.12

10577 COMPARISON OF THE TWO METHODS OF OBTAINING THE EQUATIONS OF MOTION IN GENERAL RELATIVITY.

Tan Hoang Pham.
Cahiers de Phys., Vol. 12, 399-406 (Oct., 1958). In French.

Specifies the hypotheses and the principles of each of the two methods of obtaining the equations of motion in general relativity. Under the given hypotheses, the complete equivalence of the energy-momentum tensor method and the method of singularities, is established. T.R.Carson

530.12

10578 POISSON BRACKETS BETWEEN LOCALLY DEFINED OBSERVABLES IN GENERAL RELATIVITY.

P.G.Bergmann and A.B.Komar.
Phys. Rev. Letters, Vol. 4, No. 8, 432-3 (April 15, 1960).

A new method is presented for formulating local observables, and Poisson brackets between them, in Einsten's theory of gravitation. The applicability of the method depends on functional independence of the four scalars of the Weyl tensor which can be expressed in closed form in terms of 12 canonical variables g_{mn}, p^{mn} as defined by Dirac. The method does not involve any global or topological assumptions. J.K.Skwirzynski

530.12

10579 ENERGY AND THE CRITERIA FOR RADIATION IN GENERAL RELATIVITY.

R.Arnowitt, S.Deser and C.W.Misner.
Phys. Rev., Vol. 118, No. 4, 1100-1104 (May 15, 1960).

For previous work, see Abstr. 5345 of 1959; 2106, 6660 of 1960. The Hamiltonian for general relativity obtained previously furnishes a definition of energy whose physical interpretation is direct, and which fulfils the conditions required of the energy in other physical systems. The energy can be expressed as a surface integral at spacial infinity in terms of the spacial components of the covariant metric tensor at any given time. Thus, the energy depends only on the minimal initial Cauchy data and may be evaluated in any coordinate system, provided this system can be made asymptotically rectangular. These statements remain valid when particles are coupled to the gravitational field. The criteria for existence of gravitational radiation are formulated in terms of the canonical variables and the stress-tensor. These criteria are indentical to those used in electromagnetic theory. Some applications are discussed.

530.12

10580 NULL ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY THEORY. A.Peres.

Phys. Rev., Vol. 118, No. 4, 1105-1110 (May 15, 1960).

The existance of null electromagnetic fields, within the frame of the general relativity theory, has been subject to some doubt. Here the author constructs and investigates two solutions of the Maxwell—Einstein equations, representing null electromagnetic fields, and corresponding to unidirectional radiation flow. One of these fields is coupled with transverse plane gravitaional waves, and the other one with longitudinal (not necessarily plane) gravitational waves. It is shown that not only the two electromagnetic invariants; but also the fourteen invariants of Riemann tensor, vanish. During the course of the investigation, use is made of Pirani's tetrad formalism in order to simplify Witten's spinor approach to the problem of invariants.

530.12

10581 REPRESENTATION OF MATTER IN GENERAL RELATIVITY AND IN UNIFIED THEORY. M.A.Tonnelat.

Cahiers de Phys., Vol. 13, 1-11 (Jan., 1959). In French.

The classical and non-linear field theories applied to the problem of the structure of matter permit certain new results to be obtained, and perhaps to justify classically certain corpuscular structures without authorising a comparison with the results of quantum theories. T.R.Carson

530.12 : 522

POSITIONAL ASTRONOMY AND GENERAL RELATIVITY.

See Abstr. 10469

530.12.

10582 THE THOMAS PRECESSION.

H.Zatzkis.
J. Franklin Inst., Vol. 269, No. 4, 268-73 (April, 1960).

The equation for the Thomas precession is derived by using simple matrix calculation. No knowledge of the group theory of Lobachevski geometry is assumed.

530.12

10583 FINITE SELF-ENERGY OF CLASSICAL POINT PARTICLES. R.Arnowitt, S.Deser and C.W.Misner.

Phys. Rev. Letters, Vol. 4, No. 7, 375-7 (April 1, 1960).

Considers the self-energy of a point particle in classical general relativity theory. It is shown that the gravitational self-mass of a neutral particle cancels the bare mass, giving total mass zero. A finite result is obtained for the Coulomb self-energy of a charged particle. J.Goldstone

530.12

10584 COORDINATE SYSTEMS IN GENERAL RELATIVITY AND GEOMETRICAL REPRESENTATION FOR PHYSICAL QUANTITIES. M.Ikeda and Y.Miyachi.

Suppl. Progr. theor. Phys., No. 9, 45-68 (1959).

It is pointed out that there exists some curious systems in the frame of general covariance. Physically admissible coordinate systems (PACS) and coordinate transformations (PACT) are defined and their properties investigated. General relativity is reformulated on the basis of the new principle which requires physical laws to be covariant with respect to PACT's alone. The possible forms of pseudo-quantities are determined in the frame of the new covariance principle and the geometrical representations for physical quantities are discussed. Finally a classification of PACS's is given.

530.12

10585 MATHEMATICAL ASPECTS OF EINSTEIN'S UNIFIED FIELD THEORY. F.Maurer-Tison.

Ann. Sci. Ecole Normale Super., Vol. 76, No. 3, 185-269 (July-Sept., 1959). In French.

The subject is discussed in eight chapters under three main headings as follows: (i) The field equations; (ii) The Cauchy problem for the field equations; (iii) Physical interpretation.

530.12

10586 ON THE QUANTIZATION OF THE UNIFIED FIELD IN THE JORDAN—THIRY THEORY IN THE LINEAR APPROXIMATION. A.Capella.

C. R. Acad. Sci. (Paris), Vol. 250, No. 12, 2140-2 (March 21, 1960). In French.

530.12

10587 GENERALIZATION OF THE EQUATIONS OF THE ASYMMETRIC UNIFIED FIELD. M.A.Tonnelat.

C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2327-9 (March 28, 1960). In French.

Examines extensions of general relativity which permit the application of an energy-tensor method in deducing the equations of motion. T.R.Carson

530.12

10588 WORMHOLE INITIAL CONDITIONS. C.W.Misner.

Phys. Rev., Vol. 118, No. 4, 1110-12 (May 15, 1960).

Initial conditions for the source-free Einstein equations are exhibited which represent, in a singularity-free manner on a manifold with the topology of Wheeler's "wormhole", two neutral objects of equal positive masses instantaneously at rest.

530.12

10589 THEORY OF INVARIANT VARIATION AND THE GENERALIZED CANONICAL DYNAMICS. R.Utiyama.

Suppl. Progr. theor. Phys., No. 9, 19-44 (1959).

A brief review is given of Noether's theory (1918) concerning the Lagrange formalism for systems that are invariant under some groups of transformations. Translation from the Lagrange to the canonical formalism is considered by following Rosenfeld's approach. Detailed consideration is given to the indeterminate functions which appear in the Hamiltonian as a result of the above mentioned invariance, since these functions give rise to the violation of covariance if these are regarded as c-number functions. A method of eliminating this difficulty is proposed in the case of the electromagnetic field.

530.12

10590 ON WAVE PROPAGATION IN NON-LINEAR FIELDS. T.Taniuti.

Suppl. Progr. theor. Phys., No. 9, 69-128 (1959).

The results of the characteristic theory of hyperbolic partial differential equations are summarized, and the propagation of discontinuities along characteristic lines is investigated for general quasi-linear hyperbolic systems in two independent variables. As the result, a criterion for occurrence of discontinuity waves is given. Applications to the covariant field theories are discussed. Results obtained in this study are applied directly to the investigation of occurrence of shock waves in a gravitational field. Solutions of non-linear scalar fields are analysed in detail, and non-linear electrodynamics including the Born—Infeld theory is discussed. An example of derivative interactions between spinor fields is investigated in connection with the validity of micro-causality.

530.12

10591 MATHEMATICAL STUDY OF THE PROPER FUNCTIONS OF THE INTERNAL KINETIC MOMENTS OF RELATIVISTIC FLUID MASSES. P.Hillion and J.P.Vigier.

Cahiers de Phys., Vol. 13, No. 257-82 (July-Aug., 1959). In French.

The study of the internal motions of extended relativistic fluid masses leads to the search for the proper functions of the kinetic moments expressed in terms of six Euler angles in complex conjugate pairs. These functions which are the products of complex polynomials generalising the classic polynomials of Jacobi, constitute irreducible representations of the complete Lorentz group. T.R.Carson

530.12

10592 INTERPRETATION OF THE MEAN VALUE OF INTERNAL OPERATORS IN THE THEORY OF RELATIVISTIC FLUID MASSES. P.Hillion, B.Stépanov and J.P.Vigier.

Cahiers de Phys., Vol. 13, 283-9 (July-Aug., 1959). In French.

Discusses the interpretation of the norm and the scalar product of internal wave-functions of the kinetic moments of relativistic fluid masses. (See preceding abstract). T.R.Carson

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

530.14

10593 GALILEAN INVARIANCE AND THE SCHRÖDINGER EQUATION. M.Hamermesh.

Ann. Phys. (New York), Vol. 9, No. 4, 518-21 (April, 1960).

The Schrödinger equation is derived from the assumptions of Galilean invariance and the existence of a momentum operator acting within an irreducible representation of the Galilei group.

530.14

10594 A CONTRIBUTION TO THE QUANTUM THEORY OF CENTRAL FORCES. J.Moser.

Bull. Sci. Cons. Acad. Yougoslavie, Vol. 5, No. 2, 38 (March, 1960). In German.

It is shown that the quantum mechanical central-force problem can be solved exactly within the framework of the factorization metho only if the potential is constant or proportional to r^2 or r^{-1}.

P.Roman

530.14

10595 ON THE NON-LINEAR THEORY OF WAVES. G.Lochak.

C.R. Acad. Sci. (Paris), Vol. 250, No. 11, 1985-8 (March 14, 1960). In French.

The solution is given of the Cauchy problem for plane waves governed by a non-linear equation and with the conservation of wave trains. Blokhintsev and Orlov's treatment of the Riemann—Hugoniot phenomenon is discussed. The problem is also of interest in non-linear generalizations of wave mechanics. T.R.Carson

530.14

10596 DYNAMICAL VARIABLES AND INTEGRALS OF MOTION IN THE THEORY OF QUANTIZED FIELDS. B.Stépanov.

Cahiers de Phys., Vol. 13, 173-90 (May, 1959). In French.

Gives the formal analysis of the relations between the various quantities describing the state of a system of interacting fields. Discusses in particular the question of energy-momentum and kinetic moment tensors and the covariance properties of the dynamical variables. T.R.Carson

530.14

10597 APPLICATION OF THE GRAPHICAL POLYGON METHO TO OPERATIONS ON SLATER WAVE-FUNCTIONS WITH REAL NON-ORTHONORMAL ORBITALS (SLIDING CHART METHOD ["METHODE DE GLISSEMENT"]). I.Samuel.

Cahiers de Phys., Vol. 13, 191-5 (May, 1959). In French.

Describes a method of calculating matrix elements between determinantal wave-functions, in which two charts, each listing the elements of one of the determinants, are juxtaposed in different ways to identify different terms. The method is a development of that in Abstr. 3419 of 1958. J.Hawgood

530.14

10598 A CYBERNETIC VIEW OF QUANTIZATION. A.Laforgue.

Cahiers de Phys., Vol. 13, 495-508 (Dec., 1959). In French.

A discussion of the ways in which a discrete particle may be represented for purposes of cybernetic calculation. Representation in terms of a table of values corresponding to possible co-ordinates of the particle is rejected in view of the complexity of the problem. It is shown however, that a wave-mechanical method can be used involving the concept of error potential. G.D.Sims

530.14

10599 NON-EXISTENCE OF BOUND STATES WITH POSITIVE ENERGY. T.Kato.

J. Phys. Soc. Japan, Vol. 14, No. 3, 382 (March, 1959).

An asymptotic condition on a non-symmetric potential is stated, the proof appearing in Communications on Pure and Applied Mathematics, Vol. 12 (1959). W.A.Hepner

530.14

10600 SIGNIFICANCE OF POTENTIALS IN QUANTUM THEORY. W.H.Furry and N.F.Ramsey.

Phys. Rev., Vol. 118, No. 3, 623-6 (May 1, 1960).

The effects of the scalar and vector potentials in quantum mechanics, which were pointed out recently by Aharanov and Bohm (Abstr. 12997 of 1959), are discussed from the point of view of the consistency of the quantum-mechanical description of interference experiments. A well-known requirement for this consistency is that if any measuring device is introduced that can be used to determine which path the particle has taken, it must have the effect of eliminating the interference phenomenon. Two conceptual experiments are discussed, corresponding to the two phase effects noted by Aharanov and Bohm. In each case it is found that the phase effect is of just the magnitude required to destroy the interference pattern when the circumstances are such that no pattern should be observed.

530.14

10601 LAGRANGIAN FORMALISM FOR SPIN VARIABLES. D.V.Volkov and S.V.Peletminskii.

Zh. eksper.teor. Fiz., Vol. 37, No. 1(7), 170-8 (July 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 121-6 (Jan., 1960).

It is shown that a change of the class of allowable variations in the Schwinger variational principle makes it possible to include the spin variables in the general Lagrangian formalism in both the non-relativistic and relativistic cases.

STATISTICAL MECHANICS TRANSFER PROCESSES

530.16

10602 COMPARISON BETWEEN THE CLASSICAL AND QUANTAL ASPECTS OF ERGODIC THEORY. R.Jancel.

C. R. Acad. Sci. (Paris), Vol. 250, No. 12, 2152-4 (March 21, 1960). In French.

530.16

10603 FORMULATION OF STATISTICAL MECHANICS IN TERMS OF OCCUPATION NUMBERS OF QUANTIZED STATES. R.Balian, C.Bloch and C.De Dominicis.

C.R. Acad. Sci. (Paris), Vol. 250, No. 17, 2850-2 (April 25, 1960). In French.

It is claimed that a diagram technique, together with the application of an algebraic theorem and the introduction of an appropriately defined self-consistent field, allow a simple expression of the thermodynamic quantities, in terms of the occupation numbers of elementary states. H.N.V.Temperley

530.16

10604 EXTENSION OF THE CONCEPT OF EFFECTIVE CROSS-SECTION. M.Bayet.

J. Phys. Radium, Vol. 19, No. 1, 73-5 (Jan., 1958). In French.

Definitions of effective cross-sections are given: (a) in the case of a system of particles in thermodynamic equilibrium; (b) in the case of "long range" forces (Coulomb interaction); (c) in the two preceding cases simultaneously. Case (b) has application to the stopping power of heavy charged particles and (c) to plasmas.

530.16

10605 QUANTUM STATISTICS OF NONIDEAL SYSTEMS. H.Stillinger Jr, and J.G.Kirkwood.

Phys. Rev., Vol. 118, No. 2, 361-9 (April 15, 1960).

A new cluster development for the logarithm of the grand partition function of a system of interacting particles is derived. The leading term in this expansion is the pressure exerted by an ideal Bose or Fermi gas at the same temperature and absolute activity Z as the actual system. Succeeding terms involve quantum cluster integrals which themselves depend upon Z, unlike their classical analogues. The definition of these cluster integrals follows in a natural fashion using techniques illustrated by construction (in closed form) of the successive Z derivatives of the Bose and Fermi ideal-gas grand partition functions. It is not possible (except in the classical limit) to eliminate Z explicitly between the pressure and density series, so that the equation of state must remain in parametric form.

530.16

10606 THE GREEN'S FUNCTIONS METHOD IN QUANTUM STATISTICS. E.S.Fradkin.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1286-98 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 912-19 (Oct., 1959).

A Green's function method in quantum statistics is developed. It is shown that the equations obtained contain in a simple approximation the various methods of statistical physics and of many-body theory, and also their generalization to cases of non-zero temperature (e.g. the methods of Debye—Hückel, Hartree—Fock, Thomas—Fermi, Gell-Mann and Brueckner). A transition to time-dependent Green's functions is considered, and a method given for the determination of the energy spectrum.

530.16

10607 GROUND-STATE ENERGY OF A MANY-FERMION SYSTEM. II. J.M.Luttinger and J.C.Ward.

Phys. Rev., Vol. 118, No. 5, 1417-27 (June 1, 1960).

For Pt I, see Abstr. 8568 of 1960. The perturbation series for the ground-state energy of a many-fermion system is investigated to arbitrary order for the "isotropic" case. This is the case of overall spherical symmetry, both in the interaction and in the unperturbed single particle energies. It is shown that for spin one-half fermions the Brueckner—Goldstone perturbation series is valid to all orders in the perturbation. For spins greater than one-half it is in general incorrect even in the isotropic case, unless the interactions are spin independent. The discussion to arbitrary order in the interaction is carried out by means of a Feynman-like propagator formalism, which is developed in detail.

530.16

10608 THE CONDITIONS OF APPLICABILITY OF STATISTICAL FORMULAE TO A DEGENERATE FERMI GAS.

Ya.B.Zel'dovich and E.M.Rabinovich.

Zh. eksper. teor. Fiz., Vol. 37, No. 5 (11), 1296-302 (Nov., 1959). In Russian.

A degenerate ideal Fermi gas in an arbitrary potential field is considered. It is shown that statistical formulae can be applied to the problem of variation of density under the action of a potential V(r) if the motion of particles with Fermi-boundary energy is quasi-classical in the potential field. This statement is consistent with the nonapplicability of the quasi-classical approximation to the motion of particles with smaller energy and in particular to bound particles when $V < 0$. The corrections to the statistical formulae in the one-dimensional and three-dimensional problems have opposite signs.

530.16

10609 LOW-LYING EXCITATIONS IN A BOSE GAS OF HARD SPHERES. F.Mohling and A.Sirlin.

Phys. Rev., Vol. 118, No. 2, 370-8 (April 15, 1960).

The pseudopotential method is used to calculate the low-lying excitation of a Bose gas of hard spheres at T = 0 to an order beyond that previously calculated by this technique. The results are in agreement with those obtained by Beliaev (Abstr. 6650-1 of 1958) using a different approach. The phonon velocity is found to be equal to the velocity of compressional waves to the order of approximation considered.

530.16

10610 THE EVALUATION OF COORDINATE PROBABILITIES FOR NONLINEAR SYSTEMS BY GIBBS' METHOD.

V.B.Magalinskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1423-7 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1011-14 (Nov., 1959).

Using the general principles of Gibbs' statistical mechanics, a method is developed which enables one to evaluate the transition probability density for any generalized coordinate in a system with a nonlinear relaxation mechanism. This method does not require a knowledge of the law of motion for the average value of the coordinate, but uses only the general form of the corresponding equation of motion.

530.16

10611 POINTS OF MULTIPLICITY c OF PLANE BROWNIAN PATHS.

A.Dvoretzky, P.Erdős and S.Kakutani.

Bull. Res. Counc. Israel, Vol. 7F, No. 4, 175-80 (Dec., 1958).

In a previous paper (Abstr. 2445 of 1955) it was proved that almost all Brownian paths in the plane have points of arbitrary high finite multiplicity. In the present paper, this result is strengthened by establishing that almost all Brownian paths in the plane have points of multiplicity c (the power of the continuum).

530.16

10612 DYNAMICAL MODEL IN THE THEORY OF THE BROWNIAN MOTION.

V.B.Magalinskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1942-4 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol.36(9), No. 6, 1381-2 (Dec., 1959).

Considers an oscillator with mass m and frequency ω_0 linearly coupled with a set of a large number of independent harmonic oscillators with frequencies ω_k ($k = 1, 2, \ldots, N$; $N \gg 1$). A simple derivation is given of some general relations in the theory of Brownian motion.

530.16

10613 AN EQUATION FOR THE DIFFUSION IN PHASE SPACE FOR NONLINEAR SYSTEMS.

V.B.Magalinskii and Ya.P.Terletskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1731-5 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1234-6 (Dec., 1959).

Generalizes the method developed in Abstr. 7721 of 1958 and in the preceding abstract to the case of diffusion in phase space. Starting only from the general rules of statistical mechanics and an assumption about the form of the averaged nonlinear macroscopic equation of motion for the system, a general space—velocity equation of motion for the probability density is derived. In the particular case of a linear law of friction, this equation is the same as the Einstein—Fokker—Planck space—velocity equation. For a system with a non-linear frictional force which does not depend on the coordinates in a uniform external field, the general solution of the present diffusion equation is obtained.

530.16

10614 IRREVERSIBLE PROCESSES IN GASES. I. THE DIAGRAM TECHNIQUE.

I.Prigogine and R.Balescu.

Physica, Vol. 25, No. 4, 281-301 (April, 1959).

A diagram technique is introduced to permit the asymptotic study of the solutions of Liouville's equation in the limiting case of N large, V/N constant. The topological properties of the diagrams are found to be related to the asymptotic behaviour of the various terms.

H.N.V.Temperley

530.16

10615 IRREVERSIBLE PROCESSES IN GASES. II. THE EQUATIONS OF EVOLUTION.

I.Prigogine and R.Balescu.

Physica, Vol. 25, No. 4, 302-23 (April, 1959).

The general method developed in a former paper (see preceding abstract) is applied to some typical cases, including those of weak interactions and non-homogeneous gases, various previously obtained results being reproduced. The case of strong interactions is studied briefly and it is also claimed that the apparent irreversibility of large assemblies is satisfactorily explained.

H.N.V.Temperley

530.16

10616 IRREVERSIBLE PROCESSES IN A PLASMA.

R.Balescu.

Physica, Vol. 25, No. 4, 324-5 (April, 1959).

The diagram technique is applied to a plasma (see preceding abstracts) and some preliminary results are reported briefly.

H.N.V.Temperley

530.16 : 533.7

ON THE APPROACH TO EQUILIBRIUM OF QUANTUM GASES.

See Abstr. 8687

530.16

10617 ON THE TRANSPORT EQUATION IN QUANTUM GASES.

I.Prigogine and S.Ono.

Physica, Vol. 25, No. 2, 171-8 (Feb., 1959).

It is shown that the diagram technique developed by Prigogine and Balescu (see preceding abstracts) for classical systems applies without modification to the quantum case. The only difference is the definition of a vertex, to which corresponds in the quantum case a finite momentum transfer, but in the classical case an infinitesimal transfer. This result permits a considerable simplification of the quantum calculations. By way of example, the transport equation for a weakly coupled gas is established. It is shown that this equation changes character when the characteristic length of inhomogeneity becomes of the same order as the de Broglie wavelength of the particles. In this case, the transport equation takes on a remarkable non-local form. In this way one obtains an interesting limitation of the usual theory of transport phenomena when applied to quantum problems.

O.Penrose

530.16 : 539.11

QUANTUM MECHANICAL TRANSPORT THEORY.

See Abstr. 9298

530.16 : 539.12

10618 RANDOM-WALK INTERPRETATION AND GENERALIZATION OF LINEAR BOLTZMANN EQUATIONS, PARTICULARLY FOR NEUTRON TRANSPORT.

E.Guth and E.Inönü.

Phys. Rev., Vol. 118, No. 4, 899-900 (May 15, 1960).

The connection between linear recurrence relations which define generalized random walks and the related linear Boltzmann equations is clarified. The probability distribution $f_n(s)$ for "the state s" reached by a "random walker" after n steps satisfies the recurrence relation

$$f_{n+1}(t) = \int f_n(s)P(s,t)ds,$$

where the non-negative $P(s,t)$ is the probability for a transition from s to t. The Boltzmann distribution is given by

$$f(s) = \Sigma_{n=0}^{\infty} f_n(s).$$

In general, $f_n(s)$ contains more information than $f(s)$. Moreover, $f_n(s)$ is the n-th term in the iteration series solution of the Boltzmann equation and therefore can also be obtained from the solution of an associated Boltzmann equation which contains an additional parameter. As an example, the well-known integral Boltzmann equation for neutron transport in a nonmultiplying infinite medium is derived from a $P(s,t)$ which involves a transition in a seven-dimensional phase-time space. Brownian motion and Rayleigh's problem (related to neutron thermalization) may be treated similarly.

530.19

10619 CONVERGENCE OF THE WICK-CHANDRASEKHAR APPROXIMATION TECHNIQUE IN RADIATIVE TRANSFER. II.

P.M.Anselone.

Astrophys. J., Vol. 130, No. 3, 881-3 (Nov., 1959).

An extension of previous work; for Pt I, see Abstr. 7815 of 1959. Let $I(\tau, \mu)$ and $J(\tau)$ denote the intensity and average intensity in the classical transfer problem (Milne's restricted problem). Let $I_m(\tau, \mu$ and $J_m(\tau)$ denote the corresponding Chandrasekhar approximations based on either the Gauss or the "double Gauss" quadrature formula. It is proved that $I_m(\tau,\mu) \rightarrow I(\tau,\mu)$ and $J_m(\tau) \rightarrow J(\tau)$ uniformly for all τ and μ.

530.19 : 535.31

FOCUSING OF RADIATION BY A RANDOM SURFACE.

See Abstr. 8769.

GENERAL MECHANICS

531.25

10620 **FORCES AND DEFORMATIONS IN AN ELASTIC SPHERE WITH A RADIAL VARIATION OF THE TRANSVERSE RIGIDITY AND SUBJECT TO A TANGENTIAL TORSIONAL FORCE IN THE SURFACE.** M.T.Vacca.
Atti Accad. Sci. Torino I, Vol. 94, No. 1, 54-66 (1959-60). In Italian.

A mathematical treatment with three different laws for the variation of rigidity: (1) simple power law; (2) constant value to a fixed radius and then simple power law; (3) an exponential square law. J.Hough

531.25

10621 **ON THE PLANE PROBLEM OF NON-HOMOGENEOUS ELASTIC BODIES.** P.P.Teodorescu and M.Predeleanu.
Acta tech. Hungar., Vol. 27, No. 3-4, 349-69 (1959). In German.

The plane stress problem in an isotropic material of constant Poisson's ratio is discussed, primarily in the case when Young's modulus varies exponentially with distance measured in a certain direction in the plane of deformation. J.G.Oldroyd

531.25

10622 **DEFORMATION OF A POROUS VISCO-ELASTIC BODY CONTAINING A FLUID UNDER STEADY PRESSURES.** G.Paria.
Bull. Calcutta Math . Soc., Vol. 50, No. 2, 72-6 (June, 1958).

The plain strain deformation of a circular cylinder is found when steady pressures are applied on the boundary through a perfectly pervious sheath. The theory adopted is that given by Biot (1956). The boundary displacement is evaluated by an approximate method.

531.25

10623 **THEORY OF ELASTICITY. ON A POTENTIAL REPRESENTATION IN THE THREE-DIMENSIONAL PROBLEM OF ELASTODYNAMICS.** P.P.Teodorescu.
C.R. Acad. Sci. (Paris), Vol. 250, No. 10, 1792-4 (March 7, 1960). In French.

A solution of the problem of stress, using various arbitrary displacement functions, is given. The analysis is performed with the aid of the operators

$$\Box_i = \Delta - \frac{1}{c_i^2}\frac{\partial^2}{\partial t^2} \quad (i = 1,2),$$

where Δ is the spatial Laplace operator and c_i are the two wave velocities. This treatment is a generalization of the author's previous work [Studii si cercertări de mecanica aplicata, Vol. 8, No. 4, 1101 (1959)]. R.Bullough

531.25

10624 **SOME INTERRELATIONS BETWEEN SOLUTIONS OF PLANE AND OF AXIALLY-SYMMETRICAL PROBLEMS; SOLUTIONS OF AXIALLY-SYMMETRICAL PROBLEMS BY MEANS OF ANALYTIC FUNCTIONS.** A.Ya.Aleksandrov.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 4, 754-7 (Dec. 1, 1959). In Russian.

Continuation of Abstr. 3473 of 1960. Here, the solution of an axially-symmetrical hole in an infinite flat plate is determined in terms of two independent analytic functions of a complex variable, which are themselves solutions of two integral equations of the Abel type. J.K.Skwirzynski

531.25

10625 **THE ELASTIC FIELD OUTSIDE AN ELLIPSOIDAL INCLUSION.** J.D.Eshelby.
Proc. Roy. Soc. A, Vol. 252, 561-9 (Oct. 27, 1959).

The results of an earlier paper, Proc. Roy. Soc. A, Vol. 241, 376-96 (Aug. 20, 1957), are extended. The elastic field outside an inclusion or inhomogeneity is treated in greater detail. For a general inclusion the harmonic potential of a certain surface distribution may be used in place of the biharmonic potential used previously. The elastic field outside an ellipsoidal inclusion or inhomogeneity may be expressed entirely in terms of the harmonic potential of a solid ellipsoid, The solution gives incidentally the velocity field about an ellipsoid which is deforming homogeneously in a viscous fluid. An expression given previously for the strain energy of an ellipsoidal region which has undergone a shear transformation is generalized to the case where the region has elastic constants different from those of its surroundings. The Appendix outlines a general method of calculating biharmonic potentials.

531.25

10626 **THERMAL STRESSES IN A SEMI-INFINITE ELASTIC SOLID DUE TO PERIODIC TEMPERATURE DISTRIBUTION OVER A PORTION OF ITS PLANE SURFACE.** B.Sharma.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 4, 258-63 (1957).

A new method of solving three-dimensional problems of thermal stresses in an isotropic elastic solid has been described in this paper, and the method has been applied to the solution of the problem of a semi-infinite elastic solid having periodic supply of heat on a portion of its plane surface.

531.3

10627 **HEREDITARY DYNAMIC SYSTEMS.** T.Vogel.
Cahiers de Phys., Vol. 13, 319-28 (July-Aug., 1959). In French.

These systems, whose evolution is in part determined by their past history, are defined, by assumptions due to Volterra (1913). The sub-class of "regular" hereditary systems, discussed here, is obtained from two additional assumptions, one of which gives the (separable) time factor an exponential form. The special case of an oscillator with one degree of freedom is considered in detail:

$$\ddot{x} + f\left[x, \dot{x}, \int_{\blacksquare}^{t} \exp a(t' - t).\, g(x,\dot{x})\right] dt = 0.$$

The existence and stability of periodic solutions of this equation are discussed. The case $a = 0$, $g(x,\dot{x}) = \dot{x}g'(x)$ leads to the concepts of "degenerate" and "latent" heredity. Hereditary boundaries of domains (of a phase space) are mentioned and a formal example of what could be a macroscopic theory for fatigue in materials is worked out. G.A.Chisnall

531.5

10628 **AN ABSOLUTE MEASUREMENT OF THE ACCELERATION DUE TO GRAVITY AT OTTAWA.** H.Preston-Thomas, L.G.Turnbull, E.Green, T.M.Dauphinee and S.N.Kalra.
Canad. J. Phys., Vol. 38, No. 6, 824-52 (June, 1960).

An apparatus for determining the absolute value of gravity by measuring the distances through which a rule falls in discrete time intervals is described. From the data associated with 64 drops with two non-magnetic stainless steel rules in vacuum, a value of g at the absolute gravity station Ottawa of 980.6132 cm sec^{-2} with a possible error of ±0.0015 cm sec^{-2} was obtained. This value is 13.7 ± 2.0 milligal less than the Potsdam value at that position.

531.5

10629 **DEPTH OF INDENTATION ON AN IMPACTING PROJECTILE.** R.A.Graham.
J. appl. Phys., Vol. 31, No. 3, 619-20 (March, 1960).

In a series of experiments in which a 1018 steel projectile was fired at a high velocity and impacted on a barium titanate ceramic target, the depth of indentation of the flat face of the projectile by the flat face of the target was measured. The curve of indentation depth against projectile velocity shows a knee at a velocity of 270 ft/sec, where there is also a change in the appearance of the indented surface. These and similar measurements on quartz are in qualitative agreement with the indentation mechanism proposed by Backman (Abstr. 11871 of 1959). L.E.Cross

MECHANICAL MEASUREMENTS

531.71 : 535.8

SEALED-OFF Hg^{198} ATOM-BEAM LIGHT SOURCE AS LENGTH STANDARD. See Abstr. 10758

531.72 : 539.26

10630 **MEASUREMENT OF THIN METAL LAYERS. FLUORESCENT X-RAY PRODUCTION BY RADIOISOTOPE SOURCES.** C.B.Cook, C.E.Mellish and J.A.Payne.
Analyt. Chem., Vol. 32, No. 6, 590-3 (May, 1960).

The use of radioactive isotopes for the measurement of thin films is discussed. One reason for the flexibility of the method is that there are three different methods of applying it; by using the

K X-ray excitation, the L X-ray excitation, and the absorption of X-rays excited in the base metal. A second reason is that a different response can be obtained by varying the radioactive source used. These points are illustrated by measurements on chromium, tin and copper plate. It is shown that the method is limited, for the measurement of thickness, to thicknesses of less than about two half thicknesses of absorption of the fluorescent X-rays in the metal itself. These half thicknesses of self-absorption are given for a number of elements. The maximum thickness measurable in aluminium, for example, will be ~ 4 mg/cm^2, while in cadmium the corresponding value is 102 mg/cm^2.

C.F.Barnaby

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

532.5 : 533.7

10631 FLUID DYNAMICS. C.A.Sleicher, Jr, R.A.Stern, L.E.Scriven and A.K.Oppenheim.

Industr. engng. Chem., Vol. 52, No. 4, 347-58 (April, 1960).

Review of recent literature (books, periodicals, conference proceedings and reports) on the following: equations of motion and stability; turbulence; vortex flow and rotation; jets and wakes; flow near solid surfaces; multiphase and free-boundary flow; gas dynamics; gas wave dynamics; dynamics of reactive fluids; dynamics of conducting fluids. The bibliography (arranged under the foregoing headings) comprises 252 items.

532.5 : 533.6

HYDRAULIC ANALOGUE FOR ONE DIMENSIONAL UNSTEADY GAS DYNAMICS. See Abstr. 8678

532.5

10632 AN ABSOLUTE VISCOMETRIC METHOD. J.C.Armbruster, P.Azou and P.Bastien.

C.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2816-18 (April 20, 1960). In French.

The oscillations of a liquid in a cylindrical crucible have been used to develop an absolute viscometer, correction being made for the meniscus effect. A corrected formula is proposed and verified using H_2O, C_2H_5OH, CCl_4, C_6H_6 and Hg.

G.I.W.Llewelyn

532.5 : 534.22

INFLUENCE OF CHEMICAL VISCOSITY AND OF HEAT TRANSFER ON THE VELOCITY OF FLOW AT A CONSTRICTION. See Abstr. 10722

532.5 : 536.2 : 532.5 : 621.313.2

THE THERMAL PROCESSES IN ELECTROMAGNETIC INDUCTION PUMPS. See Abstr. 10792

532.5 : 538.3 : 621.65 : 621.313.33

AN ELECTROMAGNETIC PUMP WITH CONSTANT CURRENT. See Abstr. 9149

532.5

10633 ON THE FLOW OF A NON-NEWTONIAN LIQUID ON A ROTATING DISK.

A.Acrivos, M.J.Shah and E.E.Petersen.

J. appl. Phys., Vol. 31, No. 6, 963-8 (June, 1960).

The equations describing the flow of a power-law non-Newtonian fluid on a rotating disk have been solved in general form. This makes it possible to calculate how the shape of an initial surface contour will vary with time and to investigate the possibility of producing uniform films by applying the materials to a rapidly spinning disk. It is shown that the latter process, which has potential industrial applications, has a much better chance of succeeding if the fluid is Newtonian than if it is not in the sense that whereas for a Newtonian substance centrifugation will smooth out irregularities in the surface contour, for a non-Newtonian fluid even an initially uniform film thickness will be deformed by rotating the plate.

532.5 : 535.55

FLOW ANISOTROPY IN PURE LIQUIDS. See Abstr. 8811.

532.5

10634 EXACT THEORY OF FLOW INTO A PARTIALLY PENETRATING WELL. D.Kirkham.

J. geophys. Res., Vol. 64, No. 9, 1317-27 (Sept., 1959).

An exact theory is presented for the flow into a well that partially penetrates a confined aquifer. An exact expression for the potential function is obtained, and from it an exact expression for the well flux is derived. Although the formulae obtained are complex, numerical calculations have been carried out for several flow geometries. Two flow nets have been prepared, one for a well of zero % penetration of the aquifer; the other, 60%.

532.5

10635 OPTICAL SCANNING OF LIQUID CONCENTRATION IN FLOW STUDIES WITH POROUS MODELS. E.R.Deutsch.

Nature (London), Vol. 185, 675-6 (March 5, 1960).

Description of a method for optical scanning of concentration profiles in two intermiscible liquids flowing through a porous medium. Great advantage results from the use of an aggregate of spherical glass beads, between which the liquids flow; the beads are of optical glass of refractive index equal to the liquid being used so that the porous medium produced is transparent. Glass beads have the additional advantage of being readily conditioned from water-wet to oil-wet. One liquid is dyed and the flow studied colorimetrically using a photomultiplier for high sensitivity.

T.C.Toye

532.5

10636 VARIATION PRINCIPLES OF HYDRODYNAMICS. C.Eckart.

Phys. of Fluids, Vol. 3, No. 3, 421-7 (May-June, 1960).

It is shown that the Lagrangian equations for the motion of both incompressible and compressible fluids can be derived from variation principles. As has been pointed out by Lin, an important feature of these principles is the boundary condition: the coordinates of each particle (and not merely the normal component of its velocity) must be specified. A systematic application of known results from the calculus of variations reveals new interrelations between such hydrodynamic results as Bernoulli's principle and the circulation theorem. Their derivation is both simplified and systematized. Clebsch's transformation is found to have an important relation to the problem of integrating the vorticity equation. The general solution of this problem for nonbarotropic flow is obtained. This reduces the second-order Lagrange equations to a set of first-order equations, in which the potential of the irrotational component replaces the pressure. The entropy gradients and a remarkable quantity, defined as the time-integral of the temperature of a particle of the fluid, also appear.

532.5 : 536.42

HYDRODYNAMICS OF A TWO-COMPONENT LAYER. THE THEORY OF CRISES IN THE PROCESS OF BOILING. See Abstr. 8848

532.5

10637 CROSS STRESSES IN THE LAMINAR FLOW OF LIQUIDS. M.Reiner.

Phys. of Fluids, Vol. 3, No. 3, 427-32 (May-June, 1960).

It is shown that cross-elasticity effects exist in a simple homogeneous liquid such as toluene. These effects manifest themselves in cross stresses observed in an instrument consisting of two circular metal plates, one stationary, the other rotating opposite it. The stator can be displaced along the axis of rotation against forces exerted by springs. Stator and rotor are in contact when at rest. When the rotor is brought into rotation, cross stresses in the liquid separate stator from rotor and a bearing effect is produced.

532.5

10638 EDGE EFFECTS AND THE STABILITY OF PLANE COUETTE FLOW. K.M.Case.

Phys. of Fluids, Vol. 3, No. 3, 432-5 (May-June, 1960).

The effects of edges on the stability of a uniform shear flow past one or two parallel plates is investigated in the inviscid limit. It is shown that no instabilities are produced.

532.5

10639 EXPERIMENTAL INVESTIGATION OF CONCENTRATIO CONVECTION PROCESSES IN VERTICAL OR SLIGHTLY INCLINED CIRCULAR TUBES. V.B.Shein.

Zh. tekh. Fiz., Vol. 29, No. 9, 1162-6 (Sept., 1959). In Russian.

English translation in: Soviet Physics—Technical Physics (New York), Vol 4, No. 9, 1060-4 (March, 1960).

The effect of length and diameter of the connecting tube between a solution (sugar or copper sulphate solutions) and its solvent on mixing by laminar and turbulent flow under the action of the gravitaional field was examined. R.Schnurmann

532.5 : 551.5

10640 TURBULENCE IN SHEAR FLOW WITH STABILITY. A.S.Monin.

J. geophys. Res., Vol. 64, No. 12, 2224-5 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The turbulence energy balance is considered under conditions of mean-flow shear and varying density stratification, and it is concluded that: in a stable atmosphere the total turbulence energy is reduced; the maximum of the spectrum shifts to smaller scales; and at heights large compared with the mixing length, the effects of the surface are negligible, the turbulence tends to be homogeneous, and the shear to be constant. On the other hand, when the atmosphere is unstable, the total energy and scale tend to increase, the surface always exerts an important influence, turbulent mixing is very intensive, and shear tends toward zero.

532.5 : 533.7

PRESSURIZED DISCHARGE OF LIQUID FROM A CLOSED VESSEL. See Abstr. 10693

532.5

10641 A SIMPLE METHOD FOR OBSERVING CAVITATION IN LIQUIDS. I.G.Mikhailov and V.A.Shutilov.

Akust. Zh., Vol. 5, No. 3, 376-8 (1959). In Russian. English transation in: Soviet Physics—Acoustics (New York), Vol. 5, No. 5, 385-7 (Feb., 1960).

An apparatus is described for measuring the cavitation threshold ntensity utilizing the volume expansion which occurs at the onset of cavitation. Values for the cavitation thresholds of certain liquids at 589 kc/s are given. J.Jarzyński

532.5

10642 NONLINEAR OSCILLATIONS OF A PARTICLE IN A LONG WAVE IN A ROTATING FLUID. S.-K.Kao.

J. geophys. Res., Vol. 65, No. 1, 279-86 (Jan., 1960).

The effects of a long wave of finite amplitude on the oscillation of a particle in a rotating fluid are examined by solving the Lagrangian equations of motion. It is shown that the motion of the particle is nonoscillatory or oscillatory, depending respectively on whether the forcing frequency kUr is equal to multiples of the natural frequency or not. In the former case, the zeroth-order solution consists of the natural and forcing frequencies, whereas the first-order solution gives three new frequencies. In the latter case, the zeroth-order solution consists of the natural frequency with linearly growing amplitude, whereas the first-order solution gives a high frequency oscillation of twice the natural frequency with linearly growing amplitude. A comparison of the frequencies predicted by the zeroth-order and first-order solutions and those calculated from the trajectories of 300 mb constant-pressure balloons is made.

532.5 : 534.2 : 538.56 : 621.372

SURFACE WAVE EXCITATION AND PROPAGATION. See Abstr. 11036

532.6

10643 VISCOUS DAMPING OF BUBBLES. R.K.Gould and W.L.Nyborg.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 775-6 (June, 1960).

An expression is derived for the spatial distribution of viscous energy losses in the body of liquid surrounding a vibrating spherical bubble. See also Abstr. 119 of 1960.

532.6

10644 A PHOTOELECTRIC TENSIOGRAPH. A.Vérain.

J. Phys. Radium, Vol. 19, Suppl. No. 7, 91A-95A (July, 1958). In French.

The author discusses some conditions to be met by an instrument intended to measure the surface tension of a solution and to record its changes. The principle of devices developed by the author s given, and a photoelectric system based on the continuous recording of the light reflected on a plane-parallel space, in which the iquid is rising by capillary action, is described.

532.6

10645 THE EXPANSION OF GAS BUBBLES IN LIQUIDS OF HIGH VISCOSITY. Ya.N.Chernyak.

Zh. tekh. Fiz., Vol. 29, No. 10, 1273-6 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1167-70 (April, 1960).

A cavity in a liquid of viscosity η will disappear in time $t = 4\eta r_0/3\sigma$ under the action of the surface tension σ; r_0 is the initial radius of the cavity. Were the cavity filled with a gas, then the contraction would only proceed until equilibrium was reached between the gas pressure and the capillary pressure. Where a chemical reaction produces gas in a liquid and where a coalescence of gas bubbles takes place, as, for example, during the baking of a fusible clay, the viscosity of the melt controls the rate of growth of the bubbles in it. Only in a narrow range of viscosities will the rate of expansion of the bubbles be relatively large. R.Schnurmann

532.6 : 536.48

MEASUREMENT OF SURFACE TENSION AT THE BOUNDARY BETWEEN SUPERCONDUCTING AND NORMAL PHASES OF INDIUM. See Abstr. 8934

532.6 : 541.13

SURFACE TENSION OF Te—Tl ALLOYS. See Abstr. 10355

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

532.7

10646 PARAMETER OF NONLINEARITY IN FLUIDS. R.T.Beyer.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 719-21 (June, 1960).

Values of the parameter of nonlinearity for acoustics $B/A = (\rho_0/c_0^2)\,(\partial^2 p/\partial\rho^2)_s$ are given for all liquids for which experimental data are available. The experimental data indicate that B/A generally increases slowly with temperature. A method of computing B/A directly from finite-amplitude acoustic measurements is also presented.

532.7

10647 ON THE POSSIBLE EXISTENCE, FOR FLUIDS AT ALL TEMPERATURES, OF TWO STATES, ONE EXPANDED, THE OTHER CONTRACTED. J.P.E.Duclaux.

C.R. Acad. Sci (Paris), Vol. 250, No. 14, 2524-6 (April 4, 1960). In French.

It is claimed that the observed cubic relation between density-difference and pressure-difference just below the critical point is incompatible with the existence of a single function of state describing both gas and liquid phases. On the assumption that two phases exist, each with its own isotherms, even above the critical point, a simple form is deduced for the critical isotherm, but only an outline of the derivation is given. This equation is compared with experiments on paraffins and inert gases. H.N.V.Temperley

532.7

10648 ELECTRONS IN WEAK INTERACTION WITH A CHAIN OF ATOMS. P.Sah and R.Eisenschitz.

Proc. Phys. Soc., Vol. 75, Pt 5, 700-12 (May, 1960).

The weak-binding approximation to the electronic energy spectrum is applied to a one-dimensional model of a liquid. The energy is expanded in a perturbation series, every term depending upon the positions of all atoms. The absence of long-distance order is taken into account by assigning to the coordinates of the atoms a probability distribution by means of which the statistical expectation of the energy levels is obtained. Hereby the separations between neighbouring atoms are assumed to be statistically independent. At those energies which would be forbidden in a periodic chain the density of states is reduced but would vanish, presumably, only in the limit of a very large number of terms in the series being taken into account.

532.7 : 539.12

POSITRON ANNIHILATION IN AQUEOUS SOLUTIONS. See Abstr. 9343

532.7

10649 LIQUID PARTITION FUNCTION AND THE FREE ENERGY. G.H.A.Cole.

Proc. Phys. Soc., Vol. 75, Pt 5, 671-6 (May, 1960).

A procedure is proposed, involving a coupling parameter, for the determination of the partition function and free energy of a classical condensed system of particles in terms of the structure of the system (that is, short-range order) represented by the pair distribution. The present paper forms a sequence with two previous papers by the author (Abstr. 3204 of 1959 and Abstr. 6773 of 1960) concerned with the accurate calculation of the pair distribution. The present paper, when taken together with these previous papers, gives a theory for the determination of the thermodynamic properties of a classical fluid in terms of the partition function, and using the principles of particle dynamics. Errors due to the use of the superposition approximation in the calculation of the sutrcture can be controlled. The theory may be applied equally to sperical or non-spherical constituent particles.

532.7

10650 NONEQUILIBRIUM DISTRIBUTION FUNCTIONS IN A FLUID. J.L.Lebowitz, H.L.Frisch and E.Helfand.

Phys. of Fluids, Vol. 3, No. 3, 325-8 (May-June, 1960).

The behaviour of a nonequilibrium fluid is analysed on a level intermediate between that of hydrodynamics, where microstructure is totally ignored, and a phase space description, where the complete N-body problem must be solved. The study of the fluid at this level generally involves solving an appropriate transport equation. For liquids, the primary sybject of this investigation, the Fokker—Planck equation of Kirkwood is accepted as a working model and solutions are found by the methods of Chapman and Enskog and of Grad to terms linear to deviations from local equilibrium. (It is argued, however, for a different form of the pair space force than that suggested by Kirkwood and co-workers). The results are similar in form to distributions found with other kinetic models. Variational principles are also considered. It is shown that the one- and two- particle distribution functions have the property of maximizing the entropy subject ot the constraints of given densities and fluxes. Alternatively, these distributions maximize the entropy plus entropy productions in appropriate characteristic times. These variational principles do not depend on the use of the Fokker—Planck equation but appear to posses general validity.

532.7

10651 MOLECULAR DISTRIBUTION FUNCTIONS INVOLVING TWO TIMES. G.H.Vineyard.

Phys. of Fluids, Vol. 3, No. 3, 339-45 (May-June, 1960).

A kinetic theory of distribution functions for the condition of subsets of molecules in a classical fluid at two distinct times is developed. The treatment is a natural generalization of the kinetic theories of Yvon, Kirkwood, and Born and Green, and leads to differentio-integral equations linking distributions for q molecules and distributions for q + 1 molecules. A generalization of the usual superposition approximation is suggested to truncate the infinite system of equations. Symmetries and other simple properties of the two-time distribution functions are explored, and it is shown that the pair correlation that determines inelastic scattering is a reduced form of the two-body positional distribution function. Explicit distributions are not calculated.

532.7

10652 THE LIQUID FRICTION CONSTANT. G.H.A.Cole.

Nature (London), Vol. 186, 301 (April 23, 1960).

According to Kirkwood's theory of transport processes in liquids, the coefficient of viscosity is proportional, and the coefficient of thermal conductivity is inversely proportional, to a friction constant. Attempts at deriving this constant from molecular dynamics being, so far, unsuccessful, the author attempts to find it by a semi-expirical approach. For this purpose a formula given by Andrade is utilized, according to which there is a simple relation between the two transport coefficients. Thus the friction constant is expressed in terms of quantities which can be deduced from the radial distribution of the liquid in thermal equilibrium. R.Eisenschitz

532.7

10653 STATISTICAL MECHANICAL THEORY OF THE DIFFUSION COEFFICIENTS IN BINARY LIQUID SOLUTIONS. R.J.Bearman.

J. chem. Phys., Vol. 32, No. 5, 1308-13 (May, 1960).

The theory is developed from the viewpoint of the pair space linear relations. Equations for the composition dependence of the ratios of the friction and diffusion coefficients are developed. For solutions which are regular it is found that the ratio of the two self-diffusion coefficients is in the inverse ratio of the corresponding molar volumes. The assumptions of the theory are discussed critically.

532.7 : 535.43

THE THEORY OF CRITICAL OPALESCENCE IN BINARY MIXTURES. See Abstr. 10786

532.7 : 536.41 : 539.2

CONTRIBUTIONS FROM THERMAL LATTICE DEFECTS TO THE EXPANSION OF SOLID AND LIQUID METALS. See Abstr. 9893

532.7

10654 THE CONCENTRATION DEPENDENCE OF THE DIFFUSION COEFFICIENT OF A POLYMER IN SOLUTION. V.N.Tavetkov and S.I.Klenin.

Zh. tekh. Fiz., Vol. 29, No. 5, 640-6 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 571-6 (Nov., 1959).

The dependence of the differential diffusion coefficient D(C) on the concentration C is reported for two polystyrene fractions, $M = 3.5 \times 10^6$ and 5.0×10^6, in butanone and tetrachloromethane respectively. The curves show that for concentrations (a) up to 0.05 g /100 cm^3, D does not change with C; (b) from 0.1 to 0.5g/100 cm^3, D increases sharply; and (c) for large values, D becomes slower, the curves tending to linearity. For range (b), there is correspondence between the angle of inclination of the curve D = D(C) and the value of the second virial coefficient obtained from the scattering of light. For (c), the mean diffusion coefficient between solutions of concentrations C_1 and C_2 is equal to the average of D_1 and D_2 where $D_1 = D(C_1)$ and $D_2 = D(C_2)$. There are 17 references. H.H.Hodgson

532.7

10655 EQUILIBRIUM AND TRANSPORT PROPERTIES OF THE CARBON TETRACHLORIDE—METHYLENE CHLORIDE SYSTEM. C.R.Mueller and A.J.Ignatowski.

J. chem. Phys., Vol. 32, No. 5, 1430-4 (May, 1960).

Liquid densities of solutions of CCl_4 and CH_2Cl_2 were measured at 20°C, and the excess volume has been obtained. Liquid—vapour equilibrium studies were made at 30°, 35°, and 39°C, and the excess free energy of mixing has been deduced. Liquid viscosities were measured at 20°C. The excess free energy of activation for viscous flow has been calculated. Vapour viscosity measurements were made on the same system at 20°, 80°, and 140°C, as an adjunct to the theory to calculate the parameters in the Lennard—Jones potential.

532.7

10656 THERMODYNAMIC EXCESS FUNCTIONS FOR ELECTROLYTE SOLUTIONS. H.L.Friedman.

J. chem. Phys., Vol. 32, No. 5, 1351-62 (May, 1960).

A system of excess functions is developed for electrolyte solutions and other solutions with an essentially unsymmetrical solvent—solute relation. These new functions vanish for a solution whose practical (molal scale) osmotic coefficient in unit at all compositions, temperatures and pressures. The use of these excess functions offers some advantages over the methods of comparing Mayer's ionic solution theory with experiment, of representing the properties of solutions of single or mixed electrolytes, and of making qualitative interpretations of the molecular basis of thermodynamic properties. Graphs showing the ionic-strength dependence of the excess free energy, excess enthalpy, excess entropy, and excess volume are given for several aqueous solutions of single electrolytes up to 6 molal. Experimental values of the cluster integral sum, the characteristic function of the Mayer theory, have also been calculate The concentration dependence of this function is very similar to that of the excess free energy.

532.7

10657 EFFECT OF PRESSURE ON THE STRUCTURE OF AND SOUND VELOCITY IN WATER. T.Yasunaga.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 713-15 (June, 1960).

A simple model was used to describe the propagation of sound in water. This model assumed that sound waves travel at infinite velocity within the molecules and at gas kinetic velocities through the space between the molecules. Resulting calculations showed that the latter velocity increases with pressure. From the change of sound velocity and acoustical properties for normal water and from those for nonassociated water, which were obtained from acoustical data for mixtures of alcohol and water, the change of the water structure with pressure was calculated and compared with the results of Gierer and Wirtz.

532.7 : 534.22

10658 ULTRASONIC STUDIES IN GLYCEROL—ALCOHOL MIXTURES. K.Subba Rao and B.Ramachandra Rao.

Curr. Sci., Vol. 29, No. 3, 89-90 (March, 1960).

Measurements are given of ultrasonic velocity in mixtures of glycerol with water, methyl alcohol, ethyl alcohol and n-butyl alcohol. The molar sound velocity was found to vary linearly with the concentration of glycerol in spite of deviations from linear behaviour of the ultrasonic velocity and adiabatic compressibility. J.Jarzyński

532.7 : 539.2

10659 ULTRASONIC STUDIES IN MELTS AND SOLUTIONS. S.V.Subrahmanyam and J.Bhimasenachar.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 703-5 (June, 1960).

The variation of ultrasonic velocity with concentration of phenyl salicylate, o-chloronitrobenzene, stearic acid, naphthalene, m-nitrophenol, and palmitic acid in suitable solvents was studied using an ultrasonic interferometer. The linear plots of velocity versus percentage weight of the solute are extrapolated to evaluate the velocities corresponding to 100% of the solute in each case. The agreement between the values obtained from solutions using different solvents is good. Sound velocities in the melts of the above substances were also determined. It is found that the characteristic velocity obtained from data on solutions corresponds to the velocity at melting point in all cases except in that of naphthalene.

532.7

10660 ULTRASONIC ABSORPTION DUE TO CHEMICAL RELAXATION IN ELECTROLYTES. G.S.Verma.

Rev. mod. Phys., Vol. 31, No. 4, 1052-71 (Oct., 1959).

A discussion is given of different mechanisms by which sound absorption can occur in liquids, mainly by the chemical relaxation process. Methods of measurement of absorption based on both progressive and standing wave techniques are described and some results of Tamm, Kurtze and Kaiser (1953) are given of sound absorption spectra in electrolytic solutions at 20°C. The paper concludes with a discussion of the effect of concentration, temperature, pressure and dielectric constant on the observed values of absorption and relaxation frequencies. An extensive bibliography is appended. G.Mott

532.7

10661 FREQUENCY SPECTRUM OF FINITE AMPLITUDE ULTRASONIC WAVES IN LIQUIDS.

W.Keck and R.T.Beyer.

Phys. of Fluids, Vol. 3, No. 3, 346-52 (May-June, 1960).

The theory of harmonic growth for finite-amplitude sound waves in a nondissipative fluid is discussed. The perturbation analysis of such waves in a dissipative fluid has been extended to higher orders of calculation, so that the location of the maximum of the second harmonic can be ascertained with some accuracy. The results agree well with experimental data. The effective absorption coefficient for finite-amplitude waves also has been calculated to terms of higher order.

532.7

10662 THERMODYNAMICS OF AN ISOMERIC REACTION FROM ULTRASONIC RELAXATION. G.S.Verma.

Proc. Phys. Soc., Vol. 75, Pt 1, 142-4 (Jan., 1960).

The enthalpy change ΔHo of the reaction $A_1 \rightleftharpoons A_2$ (see Abstr. 3590 of 1959) is calculated for different values of the relative change in molecular volume ΔV/V, in methylcyclohexane and cyclohexane. It is found that ΔHo is seriously affected by small changes in ΔV/V, particularly when in the neighbourhood of 1% for cyclohexane; for methylcyclohexane there exist no values of ΔHo for values of ΔV/V below 4% which give the observed values of ΔCp. J.Jarzynski

532.7 : 534.22

HYPERSONIC VELOCITY IN VISCOUS LIQUIDS. BRILLOUIN SPECTRA. See Abstr. 10724

532.7

10663 INTERPRETATION OF THE ACTION OF ELECTRIC FIELDS ON THE TRANSFERS OF HEAT IN LIQUID DIELECTRICS. E.Bonjour and J.Verdier.

C.R.Acad. Sci. (Paris), Vol. 250, No. 6, 998-1000 (Feb. 8, 1960). In French.

Results of measurements on electrically conducting liquids with conductivities between 0.5 and 2×10^{-6} mho cm^{-1}, when plotted in terms of Ahsmann and Kronig's correlation formula (Abstr. 8693 of 1950), lie on a line parallel to that for insulating liquids but with reduced abscissae in the ratio of 1 to 8. By taking into account the free charges, a modified and more generally applicable correlation formula is derived. S.Weintroub

532.7 : 537.2

10664 A WAVEGUIDE INTERFEROMETER FOR DIELECTRIC STUDIES OF DILUTE SOLUTIONS OF POLAR MOLECULES. F.Hufnagel and G.Klages.

Z. angew. Phys., Vol. 12, No. 5, 202-6 (May, 1960). In German.

An instrument is described for rapid measurement of dielectric loss factors (ϵ'') at wavelengths near 1.5 cm, with an accuracy of 2% for values of ϵ'' down to 2×10^{-3}. Reflections are minimized by placing the solution between two solvent-cells, which end at windows inclined across the waveguide. The effects of asymmetry and of reflections in the interferometer system are treated theoretically. The loss factors for benzophenone and for α-chloronaphthalene, in benzene solution, are accurately proportional to the mole-fraction of solute in the range (0-0.03 mole%) studied, the loss factor per mole varying by less than 0.2% with concentration. Larger variations are expected and found for solutes with absorption maxima at wavelengths appreciably shorter than 1.5 cm. J.Sheridan

532.7 : 537.2

10665 NONUNIFORM FIELD EFFECTS IN POORLY CONDUCTING MEDIA. H.A.Pohl.

J. Electrochem. Soc., Vol. 107, No. 5, 386-90 (May, 1960).

A simplified theory of the behaviour of suspended polymer particles in a real liquid dielectric is presented. Nonuniform fields exert an attractive force of interesting magnitude on particles of high dielectric constant suspended in a liquid medium of lower dielectric constant. In a real dielectric there is an appreciable effect due to the very small currents (10^{-3} A at kilovolts applied) which even good liquid insulators support. It is shown that, in a real dielectric, the initial attraction to the central electrode felt by all particles due to the nonuniform field and its polarizing induction is gradually overcome by the repulsive effects of charge accumulated on the particles due to ionic conduction in the liquid. The "reversal time" for the particle motion is calculated and shown to be reasonable.

532.7 : 537.2

10666 STUDY OF THE EMISSION OF ELECTRICALLY CHARGED PARTICLES PRODUCED BY THE PULVERIZATION OF ELECTROLYTIC SOLUTIONS. P.Pannetier.

Ann. Phys. (Paris), Ser. 3, Vol. 5, No. 1-2, 225-63 (Jan.-Feb., 1960). In French.

The pulverization of a water surface by bubbling devices produces droplets negatively charged, and this appears to be an inherent effect and not due to secondary causes it still occurs when the surface is exposed to either a positive or a negative field. The negative charge is reduced in the case of electrolytes, and decreases as the concentration increases; it is due to the ions and not to the undissociated molecules. Data are given for HCl, NaCl, HNO_3, $LiNO_3$, KNO_3, $CsNO_3$, $Ba(NO_3)_2$, $AgNO_3$, LiF, LiI, LiOH, CH_3COOH and phenol. Electrolytes of the same conductivity have similar effects, and it is found that the anions and cations do not act by the signs of their charges but by their mobilities. Phenol and aqueous solutions of phenol give negative charges comparable with those of water, whereas the presence of CO_2 diminishes the negative charge. In addition to the effect of rupture of the surface double layer, a part of the charge is thought to be due to the rupture of the links between the water molecules resulting in the liberation of electrons. The influence of concentration and ionic mobility on the phenomena are discussed. There are 34 references. H.H.Hodgson

532.7

10667 REFRACTIVE INDEX AND DISPERSION OF THE BENZENE—CARBON TETRACHLORIDE SYSTEM.

S.E.Wood and C.H.Masland, 3rd.

J. chem. Phys., Vol. 32, No. 5, 1385-8 (May, 1960).

The refractive indices were measured at seven different wavelengths in the visible region. These indices show only slight departure from linearity in the mole fraction. The molar refractions, calculated according to the Lorentz—Lorenz equation, are not additive in the mole fraction. Moreover, no simple relation between the molar refractions and the frequency of the light source is obtained.

532.7

10668 REFRACTIVE INDEX AND DISPERSION OF THE BENZENE—METHANOL SYSTEM.

S.E.Wood, S.Langer and R.Battino.
J. chem. Phys., Vol. 32, No. 5, 1389-93 (May, 1960).

The refractive indices were measured at 25° at seven wavelengths in the visible region. The electronic polarizability of benzene, methanol and carbon tetrachloride have been calculated from the refractive indices of this system and those of the benzene—carbon tetrachloride system by use of the Böttcher equation. The data are then used to calculate the molar electronic polarizations of the carbon tetrachloride—methanol system which are found to be in good agreement with experimentally determined values. These results show that, within the experimental error, the electronic polarizabilities of the three components are independent of the composition and hence of the environment. The electronic polarizabilities of the three substances are found to follow a dispersion equation with only one term.

532.7 : 535.33 : 539.19

10669 INTERMOLECULAR FORCES AND SOLVENT EFFECTS. I. FREQUENCY SHIFTS.

G.L.Caldow and H.W.Thompson.
Proc. Roy. Soc. A, Vol. 254, 1-16 (Jan. 19, 1960).

Measurements were made on the vibrational absorption bands of HCN, DCN and other compounds containing CH and CN groups, used as solutes in a number of solvents. The results were used to examine the importance of bulk dielectric effects and of specific solute—solvent interactions in determining the positions of the absorption bands. Some ideas about the method of interaction between the solute and solvent can be obtained from the results in series of solvents of different types, and alternative mechanisms for this interaction are suggested. It is possible to relate the observed changes in the band positions with quantitative measures of the electron density at likely centres of interaction, based upon the Taft inductive and resonance factors of groups or upon quadrupole coupling constant data. Comparisons have been made with other vibrational chromophores such as C=O, and differences can be inferred about the relative significance of bulk dielectric effects and specific interactions in different cases. All the results have been discussed with reference to current theories of solvent effects on the dissolved oscillator molecule.

532.7 : 535.33 : 539.19

10670 INTERMOLECULAR FORCES AND SOLVENT EFFECTS. II. BAND INTENSITIES.

G.L.Caldow, D.Cunliffe-Jones and H.W.Thompson.
Proc. Roy. Soc. A, Vol. 254, 17-29 (Jan. 19, 1960).

The intensities and shapes of vibration bands of the H—C and D—C groups in HCN, DCN and propargyl chloride, and of the C≡N group in these and other nitriles were measured in a number of solvents. The results are discussed in relation to Buckingham's theory of solvent effects. The relative significance of bulk dielectric effect and intermolecular interaction varies in different cases. A marked contrast in the effect of solvent was found between CH_3CN and CCl_3CN used as solutes, which suggests that in the formation of solvent complexes the dipole derivative of the C≡N group may change sign. Further data were obtained about the band shapes which suggest that the Lorentz function is rarely satisfactory, and in different solvents a given vibration band may have very different contour.

532.7 : 535.33

10671 INDIUM SULFATE: RAMAN SPECTRA AND INCOMPLETE DISSOCIATION.

B.McCarroll and M.H.Lietzke.
J. chem. Phys., Vol. 32, No. 4, 1277 (April, 1960).

Raman spectral results on aqueous solutions of indium sulphate confirm previous data [Suden, Svensk kemisk Tidskrift, Vol. 66, 173, 345 (1954)] which indicate that considerable association occurs between In^{3+} and $(SO_4)^{2-}$. G.I.W.Llewelyn

532.7 : 535.33 : 539.2

THE ABSORPTION BANDS OF Cr^{3+} IONS IN SOLUTIONS, CRYSTALS AND GLASSES. See Abstr.10041

532.7 : 535.37

10672 INFLUENCE OF SECONDARY FLUORESCENCE ON THE EMISSION SPECTRA OF FLUORESCENT SOLUTIONS.

A.Budó and I.Ketskeméty.
Acta phys. Hungar., Vol. 7, No. 2, 207-23 (1957). In German.

A theoretical treatment is given of the effect of secondary fluorescence, produced by reabsorption of primary fluorescence, on emission spectra. Experimental results are compared with theory, with special reference to the effect of thickness of the solution (Abstr. 2065 of 1957). G.F.J.Garlick

532.7 : 535.37

10673 VARIATION OF THE DURATION OF LUMINESCENCE OF TRIVALENT GADOLINIUM AND TERBIUM IONS WITH THE CONCENTRATION OF COMPONENTS IN A SULPHURIC ACID—WATER SYSTEM.

E.V.Kondrat'eva.
Optika i Spektrosk., Vol. 8, No. 1, 130-2 (Jan., 1960). In Russian.

The duration of luminescent afterglow (τ) of Gd^{+++} and Tb^{+++} ions in sulphuric acid solutions of $Gd_2(SO_4)_3$ and $Tb_2(SO_4)_3$ was measured as a function of the amount of water added to these solutions. The results showed a sharp step-like fall of τ between 16 and 26% H_2O, indicating formation of fairly stable compounds at 16% H_2O ($H_2SO_4.H_2O$) and at 26% H_2O ($H_2SO_4.2H_2O$). When sulphuric acid was added to aqueous solutions of $GdCl_3$ no such step-like fall of τ was observed: in fact τ decreased slowly and continously from 0.002 sec with no sulphuric acid to 0.0006 sec at $> 25\%$ H_2SO_4. A.Tybulewicz

532.7 : 535.37

10674 INVESTIGATION OF THE DURATION AND INTENSITY OF LUMINESCENCE OF TRIVALENT GADOLINIUM AND TERBIUM IONS IN SOLUTIONS.

E.V.Kondrat'eva and G.S.Lazeeva.
Optika i Spektrosk., Vol. 8, No. 1, 132-5 (Jan., 1960). In Russian.

Reports measurements of the duration and intensity of luminescence of Gd^{+++} and Tb^{+++} ions in (1) solutions of $Gd_2(SO_4)_3$ and $Tb_2(SO_4)_3$ in water and sulphuric acid, and (2) aqueous solutions of $GdCl_3$ and $TbCl_3$. With rise of temperature the duration and intensity of luminescence of Gd^{+++} in all solutions and of Tb^{+++} in sulphuric acid solutions of $Tb_2(SO_4)_3$ fell very sharply (temperature quenching). Such quenching did not occur in aqueous solutions of $Tb_2(SO_4)_3$ and $TbCl_3$. A.Tybulewicz

532.7 : 535.37

10675 MANIFESTATION OF INTERMOLECULAR REACTIONS IN THE FLUORESCENCE SPECTRA OF THE SOLUTIO OF ACETYLANTHRACENES IN SOLVENT MIXTURES.

A.S.Cherka
Dokl. Akad. Nauk SSSR, Vol. 130, No. 6, 1288-90 (Feb. 21, 1960). In Russian.

In hexane (a non-polar solvent) the spectra of these solutions occupy the extreme short-wave position. An addition of pyridine brings about the gradual shift of the spectrum towards smaller frequencies and smoothing of the spectrum. Similar phenomena are obtained when alcohols are added, but, whereas 1% of pyridine has n visible effect, 0.1-0.2% of ethanol has a pronounced effect, pointing to the superposition of, at least, two different spectra. An attempt is made at explaining this behaviour. F.Lachma

532.7 : 535.37

10676 THE RELATIONSHIP BETWEEN THE CHEMICAL STRUCTURE AND THE SCINTILLATION EFFICIENCY OF 1,3,4-OXADIAZOLE DERIVATIVES.

O.P.Shvaika and A.P.Grek
Optika i Spektrosk., Vol. 7, No. 6, 824-6 (Dec., 1959). In Russian.

Electron-donor substituents tend to increase the scintillation (radioluminescence) efficiency of 2-phenyl- and 2, 5-diphenyl-1,3,4 oxadiazoles, while electron-acceptor substituents tend to decrease the scintillation efficiency or even reduce it to zero. The exceptio to this rule occurs when the substituents include heavy elements, such as S, Br or I, which produce quenching. When the oxygen content of solutions of these oxadiazoles was reduced by blowing nitrogen through them, the scintillation efficiency was raised quite considerably. A.Tybulewic

532.7 : 535.

10677 THE UNIVERSAL SCALE OF THE EFFECT OF SOLVE ON THE ELECTRON SPECTRA OF ORGANIC COMPOU

I.A.Zhmyreva, V.V.Zelinskii, V.P.Kolobkov and N.D.Krasnitskaya.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 5, 1089-92 (Dec. 11, 1959). In Russian.

The standard substance used is 4-amino-n-methylphthalimide.

If the ordinates represent the frequency scale, while various solvents are given such places on the abscissa axis as to make the distances between them equal to frequency differences between the fluorescence maxima in these solvents, then the points obtained for a large number of organic compounds (maximum frequencies of fluorescence spectra in various solvents) lie along straight lines; this applies also to substances other than the 21 derivatives of phthalimide studied. It was also found that all solvents with an OH-group have maxima in the range 16 000-19 000 cm^{-1} (alcohols are within this range: 17 600-19 600 cm^{-1}); esters — 18 800-21 600 cm^{-1}; ethers — 21 700-22 050 cm^{-1}; aromatic hydrocarbons — 22 000-22 500 cm^{-1}, and saturated hydrocarbons — 24 400 cm^{-1}. The state of aggregation has mostly no effect on the position of the fluorescence spectrum. F.Lachman

532.7 : 538.2

10678 ELECTRON SPIN RESONANCE IN HYDROGEN PEROXIDE — WATER SOLUTIONS AT 90° K IRRADIATED WITH ULTRA-VIOLET LIGHT.
R.C.Smith and S.J.Wyard.
Nature (London), Vol. 186, 226-8 (April 16, 1960).

The spectrum observed after the solutions had been warmed to temperatures above 130° K following irradiation differed from that observed when the solutions were kept at 90° K. The transformation from the primary to a secondary radical at about 130° K was inferred but neither radical could be identified. E.F.W.Seymour

532.7 : 538.27

10679 MEASUREMENT OF SPIN—LATTICE RELAXATION TIME IN Mn^{++} SALT SOLUTIONS. P.G.Tishkov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1337-41 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 949-52 (Nov., 1959).

A Q-meter was used to measure this relaxation time and the internal field parameters. The spin—lattice relaxation time of $\text{MnCl}_2.4\text{H}_2\text{O}$ in glycerin and water—glycerin solutions is satisfactorily described by the Casimir—Du Pré theory when allowance is made for spin—spin absorption, and is also in good agreement with the Brons—Van Vleck formula. The spin—lattice relaxation time is only slightly dependent on the paramagnetic salt concentration and on the viscosity of the solution.

532.7 : 538.27

10680 PROTON HYPERFINE SPECTRA OF DIPHENYL PICRYL HYDRAZYL. Y.Deguchi.
J. chem. Phys., Vol. 32, No. 5, 1584-5 (May, 1960).

Extensive proton hyperfine structure in the electron spin resonance of DPPH has been resolved by using dilute solutions in carefully purified solvents. Failure to observe this structure in solutions using solvents of commercial purity is probably due to dissolved oxygen. E.F.W.Seymour

MECHANICS OF GASES

533.6

10681 PULSATING FLOW MEASUREMENT — TODAY. P.H.Stirling and H.Ho.
Industr. engng Chem., Vol. 52, No. 4, 43A-44A (April, 1960).

Describes, in practical terms, the principles and applications of the Isobe—Hattori flowmeter, with special reference to the metering of pulsating gas flows.

533.6

10682 EXPANSION OF A RAREFIED GAS CLOUD INTO A VACUUM. P.Molmud.
Phys. of Fluids, Vol. 3, No. 3, 362-6 (May-June, 1960).

Analytical solutions are obtained describing the expansion into a vacuum of gas clouds having simple initial configurations. The assumptions employed are free molecular flow and local Maxwellian distribution of velocities initially. By means of a simple transformation in time, equivalence is shown between these solutions and the solutions of some elementary problems in transient heat flow. The initially uniform spherical gas cloud expanding into a vacuum is solved by two methods: (1) by the assumption of free molecular flow; and (2) by programming the conventional equations of gas dynamics. Good agreement is observed between the solutions resulting from the two treatments.

533.6

10683 TAYLOR INSTABILITY OF AN INVERTED ATMOSPHERE. K.M.Case.
Phys. of Fluids, Vol. 3, No. 3, 366-8 (May-June, 1960).

The stability of an idealized inverted atmosphere is investigated. It is shown that an initial perturbation grown in a manner similar to that found by Taylor for the instability of accelerated fluid surfaces.

533.6

10684 LAMINAR PARALLEL STREAM MIXING WITH DISSOCIATION AND RECOMBINATION.
A.A.Kovitz and R.F.Hoglund.
Phys. of Fluids, Vol. 3, No. 3, 436-44 (May-June, 1960).

The boundary layer approximation is used to obtain closed-form solutions for the approach to equilibrium in a constant velocity mixing zone, i.e., the velocity gradients are neglected and only temperature and concentration gradients are considered. The chemical system consists of symmetric diatomic molecules and their atoms. A rate of atom production is assumed that is proportional to the difference between local atom concentration and the atom concentration associated with equilibrium mixing. The limiting cases of frozen flow and equilibrium flow appear as special cases of the general solution. Initial composition before mixing and composition outside the mixing zone need not be in local chemical equilibrium. It is shown that nonequilibrium conditions outside the mixing zone can have a strong influence on the evolution toward equilibrium within the mixing zone.

533.6

10685 NONSTATIONARY TURBULENT BOUNDARY LAYER ON A WING PROFILE AND ON A FIGURE OF ROTATION. K.K.Fedyaevskii and A.S.Ginevskii.
Zh. tekh. Fiz., Vol. 29, No. 7, 916-23 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 829-36 (Jan., 1960).

A semi-empirical theory of turbulence, in a boundary layer with accelerating or decelerating main stream, is used to calculate, in particular, the variation of skin friction coefficient and of the point of separation in a two-dimensional flow past a circular cylinder in non-uniform motion. Experiment confirms the significant effect of acceleration. J.G.Oldroyd

533.6

10686 NONSTATIONARY FLOW OF A GAS AND TRANSFER OF PRESSURE THROUGH A POROUS MEDIUM.
B.M.Vetrov, I.I.Petrenko and O.M.Todes.
Zh. tekh. Fiz., Vol. 29, No. 8, 1021-31 (Aug., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 8, 930-9 (Feb., 1960).

The changes of pressure with time were recorded at various distances along a 200 cm tube packed with sand, as air passed through the sand after being suddenly released from an air reservoir maintained at about 3 atmospheres pressure. The observed passage of an air shock wave is compared with calculated pressure distributions derived from a non-linear partial differential equation for the pressure, which follows from the assumption of effectively isothermal conditions. J.G.Oldroyd

GASEOUS STATE

533.7 : 532.5

GAS DYNAMICS. BIBLIOGRAPHICAL REVIEW.
See Abstr. 10631

533.7

10687 NEW KINETIC EQUATIONS IN THE THEORY OF MONATOMIC GASES. S.V.Vallander.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 1, 58-60 (March 1, 1960). In Russian.

An integral equation equivalent to Boltzmann's integro-differential equation is formulated. O.Penrose

533.7

10688 MEASUREMENTS OF MULTICOMPONENT DIFFUSION COEFFICIENTS FOR THE CO_2—He—N_2 SYSTEM USING THE POINT SOURCE TECHNIQUE.

R.E.Walker, N.deHaas and A.A.Westenberg.
J. chem. Phys., Vol. 32, No. 5, 1314-16 (May, 1960).

Measurements of the coefficient for a trace of carbon dioxide in a mixture of helium and nitrogen of varying composition were made at room temperature and atmospheric pressure using the point source technique. The results are shown to be in agreement with the results of Fairbanks and Wilke in that an equation of the form

$$D_{i\text{-mix}} = [\Sigma_{\substack{k \\ i \neq k}} (x_k/\mathcal{D}_{ik})]^{-1}$$

can be used to relate the diffusion coefficient of a trace of species i in a mixture of composition given by the mole fraction x_k to the binary diffusion coefficients $\mathcal{D}_{ik}$. Some data are presented on the separation of the mixture in the diffusion zone.

533.7

10689 VAPOR PRESSURE EQUATIONS FOR SPECIES OVER SOLID AND LIQUID LiF.

R.S.Scheffee and J.L.Margrave.
J. chem. Phys., Vol. 31, No. 6, 1682-3 (Dec., 1959).

The equations for monomeric, dimeric, and trimeric gaseous LiF species are constructed from current vapour pressure data in the literature. Heats of sublimation are calculated. The data indicate the dimerization energy for $(LiF)_2(g) = 2\ LiF\ (g)$ to be $\Delta H = 69 \pm 4$ kcal/mole at 1100° K. W.Good

533.7 : 541.12

10690 VARIATIONAL PRINCIPLES FOR CHEMICAL EQUILIBRIUM. W.S.Dorn.

J. chem. Phys., Vol. 32, No. 5, 1490-2 (May, 1960).

Two variational principles for the chemical equilibrium of a gaseous mixture are formulated. These provide a means for calculating upper and lower bounds to the energy of the equilibrium mixture.

533.7

10691 SLIPPING AND TEMPERATURE DISCONTINUITY AT THE BOUNDARY OF A GAS MIXTURE.

R.Ya.Kucherov and L.É.Rikenglaz.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1758-61 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1253-5 (Dec., 1959).

Boundary conditions have been obtained for the hydrodynamical transport equations for a gas mixture. The conditions take into account slipping and the temperature jump at the boundary with a solid surface.

533.7

10692 THE SECOND VIRIAL COEFFICIENT OF GASEOUS MIXTURES AT 90° K.

C.M.Knobler, J.J.M.Beenakker and H.F.P.Knaap.
Physica, Vol. 25, No. 10, 909-16 (Oct., 1959).

The second virial coefficients of 13 binary gas mixtures were measured at 90° K. A new experimental method is described and the data are compared with calculations using the Lennard-Jones 6-12 potential and combination rules.

533.7 : 532.5

10693 PRESSURIZED DISCHARGE OF LIQUID FROM A CLOSED VESSEL. L.J.Kastner and T.J.Williams.

J. mech. Engng Sci., Vol. 2, No. 1, 29-34 (March, 1960).

The minimum volume of gas V_a required to discharge a volume of liquid V_b is calculated for an ideal gas, also taking account of Joule-Thomson cooling, in adiabatic conditions. The ratio V_a/V_b and the cooling effect on the liquid are tabulated. P.Gray

533.7 : 536.2

10694 APPLICATION OF THE PRINCIPLE OF CORRESPONDING STATES TO THE THERMAL CONDUCTIVITY OF THE GASEOUS STATE. Z.Losenický.

Czech. J. Phys., Vol. 9, No. 3, 399-400 (1959).

Isobars of the thermal conductivity λ for the pressure $p = 1$ kg/cm² and reduced isobars for the reduced pressure $p_r = 0.02$ for a number of different gases are plotted as a function of the reduced temperature T_r. λ is approximately the same for the same T_r for gases having the same number of atoms per molecule. From the graphs it is deduced that the accuracy in applying the principle of corresponding states to the thermal conductivity of non-polar gases is considerably increased if the material is divided into groups according to the number of atoms per molecule and a network of reduced isobars constructed for each group separately. S.Weintroub

533.7

10695 AN EXPERIMENTAL STUDY OF THE ENTHALPY OF STEAM. G.S.Callendar and A.Egerton.

Phil. Trans A, Vol. 252, 133-64 (Jan. 21, 1960).

The measurements on the total heat of steam by the condenser method carried out between the years 1931 and 1940 are described. The apparatus was adapted from that used for the measurement of the saturation pressure of steam (Egerton and Callendar 1932). Pt I deals with the investigation of the sources of error, particularly the heat-loss correction, as a result of which the modifications in the apparatus described in Pt II were made. The final measurements, amounting to about 400, range from 10 to 225 Kg/cm² and from 200 to 600° C, at intervals of about 25 Kg/cm² and 25 deg C. The smoothed results are also given in bars, and are considered to lie within about 1 part in 1500 of the true values.

533.7

10696 THERMAL CONDUCTIVITIES OF RARE GAS MIXTURES. E.A.Mason and H. von Ubisch.

Phys. of Fluids, Vol. 3, No. 3, 355-61 (May-June, 1960).

Recent measurements of the thermal conductivities of all ten possible binary mixtures of the rare gases and of the ternary mixture He—Kr—Xe at 29° and 520° C are compared with theoretical calculations. Three calculations are carried out, based on: (1) rigorous kinetic theory; (2) an approximate formula which uses only conductivities of the pure components, and (3) a new semiempirical formula which also requires knowledge of the conductivity of one composition of binary mixture. The agreement is generally satisfactory and furnishes support for the usefulness and accuracy of the formulae used.

533.7 : 536.2

THERMAL CONDUCTIVITY OF HELIUM AND HYDROGEN AT HIGH TEMPERATURES. See Abstr. 10797

533.7

10697 MASS SPECTROMETRIC INVESTIGATION OF THE SUBLIMATION OF MOLYBDENUM DIOXIDE.

R.P.Burns, G.DeMaria, J.Drowart and R.T.Grimley.
J. chem. Phys., Vol. 32, No. 5, 1363-6 (May, 1960).

A mass spectrometric investigation of the vapour in thermodynamic equilibrium with powdered molybdenum dioxide has shown the vapour phase to consist, in decreasing order of importance, of the species MoO_3, $(MoO_3)_2$, MoO_2, and $(MoO_3)_3$. The heats, entropies, and free energies of reaction have been determined for the reactions (T = 1600° K):

$\frac{3}{2}x\ MoO_2(s) \rightarrow (MoO_3)_x(g) + \frac{1}{2}x\ Mo(s)$ where x = 1, 2, 3,
$MoO_2(s) \rightarrow MoO_2(g)$ $\Delta H_T = 134.4 \pm 7$ kcal/mole
$2MoO_3(g) \rightarrow (MoO_3)_2(g)$ $\Delta H_T = -110.2 \pm 8$ kcal/mole
$3MoO_3(g) \rightarrow (MoO_3)_3(g)$ $\Delta H_T = -222.8 \pm 13$ kcal/mole

For the case x = 1, 2, 3 the ΔH_T's are 121.8 ± 3, 133.4 ± 7, and 142.6 ± 13 kcal/mole, respectively. Entropies of the gaseous molecules MoO_3, $(MoO_3)_2$, $(MoO_3)_3$, and MoO_2 at T = 1600° K are 96.6, 151.0, 201.2, and 85.5 e.u. respectively. In addition, the atomization energies ($\Delta H_0°$) for the reaction.

$$Mo\ O_x(g) \rightarrow Mo(g) + xO(g)$$

were calculated to be 277.4 ± 7 and 419.7 ± 10 kcal/mole for x = 2 and 3, respectively.

533.7

10698 THERMODYNAMIC STUDY OF Al_2O_3 USING A MASS SPECTROMETER.

J.Drowart, G.DeMaria, R.P.Burns and M.G.Inghram.
J. chem. Phys., Vol. 32, No. 5, 1366-72 (May, 1960).

The evaporation of alumina under nearly neutral conditions in tungsten and molybdenum Knudsen cells was investigated by mass spectrometric methods. The atomization energies of the gaseous molecules are $D_0°(AlO) = 115 \pm 5$ kcal/mole; $D_0°(Al_2O) = 245 \pm 7$ kcal/mole; $D_0°(Al_2O_2) = 365 \pm 7$ kcal/mole.

533.7

10699 MASS SPECTROMETRIC STUDY OF GASEOUS MOLYBDENUM, TUNGSTEN, AND URANIUM OXIDES.

G.DeMaria, R.P.Burns, J.Drowart and M.G.Inghram.

J. chem. Phys., Vol. 32, No. 5, 1373-7 (May, 1960).

Partial pressures of the gaseous oxides MoO, MoO_2, MoO_3, WO, WO_2, WO_3, UO, UO_2, and UO_3 in the systems Mo—Al_2O_3 and U—Al_2O_3 were measured by mass spectrometric methods. The vapour pressure of uranium was also determined. The reaction enthalpies derived from these measurements are:

Reaction	ΔH_0^0 kcal/mole
$MoO(g) \rightarrow Mo(g) + O(g)$	116 ± 15
$MoO_2(g) \rightarrow Mo(g) + 2O(g)$	262 ± 10
$MoO_3(g) \rightarrow Mo(g) + 3O(g)$	411 ± 7
$WO(g) \rightarrow W(g) + O(g)$	154 ± 10
$WO_2(g) \rightarrow W(g) + 2O(g)$	296 ± 7
$WO_3(g) \rightarrow W(g) + 3O(g)$	443 ± 7
$UO(g) \rightarrow U(g) + O(g)$	179 ± 7
$UO_2(g) \rightarrow U(g) + 2O(g)$	340 ± 7
$UO_3(g) \rightarrow U(g) + 3O(g)$	493 ± 7
$U(s) \rightarrow U(g)$	126 ± 5

533.7

10700 NONRESONANT ABSORPTION IN SYMMETRIC-TOP GASES: DEPENDENCE OF RELAXATION FREQUENCY ON TEMPERATURE. A.A.Maryott, A.Estin and G.Birnbaum.

J. chem. Phys., Vol. 32, No. 5, 1501-4 (May, 1960).

The nonresonant absorption spectra of CHF_3, CH_3F, and $CClF_3$ were obtained in the gaseous state at various temperatures in the range 230° to 360° K. In all cases the maximum value of the dielectric loss per unit pressure varies as T^{-2}, in accordance with the Debye equation. The variation of relaxation frequency (line width) with pressure and temperature is represented by $\Delta\nu \propto pT^{-m}$, where m has the following values: 1.59 ± 0.03 for CHF_3, 1.60 ± 0.02 for CH_3F, and 1.27 ± 0.02 for $CClF_3$, Since CHF_3 and CH_3F have rather large dipole moments, the predominant interaction should be of the first-order dipole-dipole type. On this basis Anderson's theory predicts m = 1. Closer agreement with the experimental data is obtained with an expression derived essentially from dimensional considerations of a torque-impulse model, which gives m = 1.5. In the case of $CClF_3$, which has a comparatively small dipole moment, the data indicate that molecular reorientation is governed primarily by forces of shorter range.

533.7

10701 SPIN RELAXATION AND LINE WIDTH IN ALKALI METAL VAPORS. A.L.Bloom.

Phys. Rev., Vol. 118, No. 3, 664-7 (May 1, 1960).

Relaxation constants T_1 and T_2 have been computed for experiments involving optical pumping and optical detection in alkali metal vapour. The calculations were performed for several possible spin relaxation mechanisms; namely, magnetic dipole, electric quadrupole, spin exchange, and the optical pumping process itself. For all these mechanisms a reorientation experiment will approximately predict a spin resonance line width (equivalent to the statement $T_1 \cong T_2$ for spin-$\frac{1}{2}$ particles). However, a spin reorientation experiment of the type originally performed by Dehmelt (Abstr. 6470 of 1957) employing circularly polarized light, gives approximate results because of the nonexponential character of the reorientation. A more suitable experiment is one employing hyperfine population differences and unpolarized light.

533.7 : 537.533

ENERGY ANALYSER FOR ELECTRON DIFFRACTION BY GASES. See Abstr. 9090

533.7 : 535.33

PRESSURE BROADENING STUDIES OF GASES USING OPTICALLY CALIBRATED INFRARED HIGH PRESSURE CELL. See Abstr.8799.

533.7 : 535.37 : 539.1.07

GAS SCINTILLATORS AND THEIR CONDENSED STATES. See Abstr. 9234

VACUUM PHYSICS

533.5

10702 A METHOD OF MEASURING THE SPEED OF UNIVERSAL VACUUM PUMPS. E.J.Bertomeu.

Rev. Univ. Nac. La Plata, Ser. Segunda, No. 6, 18-22 (Oct., 1959). In Spanish.

The volume to be evacuated is initially at atmospheric pressure, and a manometer shows the pressure continuously. An expression is derived connecting the speed of the pump with the rate of change of pressure over a certain small pressure range, and with the total volume being evacuated. The pump may be connected to any one of a number of vessels of different volume, thus giving a wide range of applicability. Various devices are mentioned for accurate measurement of the time taken for the pressure to change by the specified amount. N.Corcoran

533.5 : 537.52 : 621.387

10703 MECHANISM OF INERT GAS CLEANUP IN A GASEOUS DISCHARGE. K.B.Blodgett and T.A.Vanderslice.

J. appl. Phys., Vol. 31, No. 6, 1017-23 (June, 1960).

An investigation was made of the cleanup of inert gases by a gas discharge. The cleanup of rare gases in a tube in which metal is being sputtered is governed largely by two factors. First, the rate at which the metal is sputtered, and second, the potential of the surface on which the metal lands. At small negative or positive potentials on the surface collecting sputtered metal there is a slow cleanup rate caused by uncharged species being buried by sputtered metal. At more negative potentials burial of ions becomes important, and cleanup is much more rapid. Recovery was effected by heating to the evaporation temperatures of the metal. As the metal evaporates the buried gas is liberated. Hundreds of equivalent monolayers of argon were cleaned up with only a total recovery of about about one equivalent monolayer by heating at 1500°C. This shows that even with a forced "solubility" of the order of 1% no evidence was found for significant diffusion of argon in metals. An electrode collecting ions at a uniform current density over the surface will have a net cleanup rate of zero on that surface after the initial cleanup of a small amount of gas. After the initial disappearance of some gas, resputtering will occur liberating the cleaned up gas as fast as it is being cleaned up.

533.5 : 541.18

SORPTION OF ACTIVATED GASES BY TITANIUM FILMS. See Abstr. 10374

533.5

10704 ANALYSIS OF THE RESIDUAL GASES IN SEVERAL TYPES OF HIGH-VACUUM EVAPORATORS. H.L.Caswell.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 130-42 (April, 1960).

A mass spectrometer study is made of the residual gases in several types of vacuum evaporators ranging from oil-diffusion-pumped, conventional systems to an oil-free, ultra-high-vacuum chamber. Partial pressure of water vapour, hydrogen, carbon monoxide, carbon dioxide, nitrogen, oxygen, argon and hydrocarbon vapours varied appreciably in the evaporators studied. The performance of a conventional system was improved by using special low-vapour-pressure gasket materials to minimize hydrocarbon contamination, a liquid-nitrogen trap to reduce water vapour, titanium gettering for oxygen and nickel-iron gettering for hydrogen. For thin-film deposition, the importance of thoroughly outgassing the source materials is pointed out.

533.5 : 621.315.616.96 : 621.385.1

10705 EPOXY-RESIN JOINTS FOR SEALED-OFF, HIGH-VACUUM TUBES. J.F.Sayers.

J. sci. Instrum., Vol. 37, No. 6, 203-5 (June, 1960).

Joints may be made in the envelope of sealed-off, high-vacuum tubes using a synthetic resin adhesive, permitting unusual forms of construction. A pressure of 10^{-6} torr may be maintained in such a tube for several years. Success depends on suitable design and processing and on the use of getters. A special television camera tube and a vacuum photocell have been made using this technique.

VIBRATIONS · ACOUSTICS

534.1

10706 RANDOM VIBRATION. C.T.Morrow.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 742-8 (June, 1960).

There is, at present, a great interest in random vibration as a special aspect of shock and vibration, especially in relation to effects on equipment. An attempt will be made to explain what is meant by random vibration as opposed to other excitations that might be confused with it, what is involved in random vibration testing, what the corresponding objectives are, why there is controversy about these general subjects, and how some of the controversies may be resolved.

534.13

10707 VIBRATIONS OF RODS AT FREQUENCIES BELOW THEIR RADIAL RESONANCE.

H.J.Biesterfeldt, J.N.Lange and E.J.Skudrzyk.
J. Acoust. Soc. Amer., Vol. 32, No. 6, 749-64 (June, 1960).

The asymptotic vibration laws that describe the high-frequency behaviour of complex systems — on the basis of mode masses and the frequency difference between successive resonances and their damping — also give a significant description of the low-frequency behaviour of vibrators from their first resonance onwards. Thus, where problems of noise and vibration insulation are concerned, there seems to be no need for more accurate calculation. This paper derives the necessary theoretical background and substantiates the theory by means of a study of vibrating rods.

534.13

10708 COMMENTS ON "VIBRATIONS OF THICK CYLINDRICAL SHELLS". D.C.Gazis.

J. Acoust. Soc. Amer., Vol. 32, No. 5, 611-12 (May, 1960).

Clarification of alleged misinterpretation of author's work (Abstr. 6641 of 1959) in its criticism by Greenspon (Abstr. 2193 of 1960). In particular he stresses the importance of higher order modes present in flexural vibrations of thick cylindrical shells.
J.K.Skwirzynski

534.13

10709 VIBRATIONS OF THICK CYLINDRICAL SHELLS.

J.E.Greenspon.
J. Acoust. Soc. Amer., Vol. 32, No. 5, 612-13 (May, 1960).

Comment on Gazis' criticisms (see preceding abstract), stressing the importance of experimental checks and proper measurement of higher order modes. J.K.Skwirzynski

534.13

10710 VIBRATIONS OF CONICAL SHELLS.

H.Saunders, E.J.Wisniewski and P.R.Paslay.
J. Acoust. Soc. Amer., Vol. 32, No. 6, 765-72 (June, 1960).

A Rayleigh—Ritz procedure is used to determine the natural frequencies for a certain class of mode shapes of a thin conical shell built in on the edge with the smaller radius and either simply supported or free on the other edge. Both bending and extensional energies are included in the analysis. The results show that, for a sufficiently large number of circumferential nodes, the natural frequency predicted by these analyses is very close to the inextensional natural frequency for the same number of circumferential nodes and simply supported at the edge with the smaller radius. The comparison with the inextensional theory predictions is consistent with what has already been found experimentally; i.e., boundary conditions for this type of shell are not as influential on the higher natural frequencies as the lower ones.

534.15

10711 ON THE VIBRATION STATISTICS OF A RANDOMLY EXCITED HARD-SPRING OSCILLATOR. R.H.Lyon.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 716-19 (June, 1960).

The system considered is a harmonic oscillator with a hard spring excited by random noise of the "infinitesimal impulse" type. An expression for the joint density of displacement and velocity is obtained and from this, the distributions of displacements and extrema and the average number of zero crossings are found. In addition, by solving a fundamental integral equation, the shape of the distorted sine wave "carrier" for finite amplitude vibrations can be found.

534.2 : 532.5 : 538.56 : 621.372

SURFACE WAVE EXCITATION AND PROPAGATION. See Abstr. 11036

534.2

10712 ON THE ROTATION OF THE PLANE OF POLARIZATION OF ELASTIC WAVES IN A MAGNETICALLY POLARIZED MEDIUM. K.B.Vlasov and B.Kh.Ishmukhametov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1301-3 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 921-2 (Oct., 1959).

The theory of the propagation of plane-polarized transverse elastic waves, travelling along the direction of a constant magnetic field, is examined with particular reference to the case where the medium is a metal, treated on the free-electron model. It is concluded that both rotation of the plane of polarization and elliptical polarization can arise and that, in certain cases of propagation along symmetry axes, the propagation of a transverse wave must be accompanied by propagation of a longitudinal wave. L.Mackinnon

534.2

10713 ROTATION OF THE PLANE OF POLARIZATION OF ELASTIC WAVES IN MAGNETICALLY POLARIZED MAGNETO-ELASTIC MEDIA. K.B.Vlasov and B.Kh.Ishmukhametov

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 745-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 531-4 (March, 1960).

Some peculiarities of the propagation of magnetoelastic waves in magnetically polarized media are studied; the medium considered is one with uniaxial symmetry. It is shown that a magnetoelastic wave propagated along the axis of symmetry consists of three waves: a longitudinal wave and two circularly polarized waves, whose speeds of propagation are different and are determined by the magnetic state of the medium — the magnitude of the magnetization or of the polarization field. The latter circumstance should lead to rotation of the plane of polarization of linearly polarized elastic waves. The treatment is based on phenomenological "equations of state" that describe the dynamic properties of magnetoelastic media. Some remarks are made regarding the physical meaning of the constants that determine the rotation of the plane of polarization in certain specific types of magnetoelastic medium; and an estimate is made of the frequencies at which an appreciable effect is to be expected.

534.2 : 550.3

10714 A SIMPLIFIED METHOD FOR THE ANALYSIS AND SYNTHESIS OF DISPERSED WAVE TRAINS.

J.N.Brune, J.E.Nafe and J.E.Oliver.
J. geophys. Res., Vol. 65, No. 1, 287-304 (Jan., 1960).

A disturbance at one point of a dispersive medium resulting from an impulse applied at another point may be represented as a superposition of travelling plane waves. The phase and period of the disturbance at any instant are related by the principle of stationary phase to the phase and period of a travelling wave component. For the instantaneous phase of that travelling wave component the following equation may be written:

$$Ct - x = (N - \varphi_0/2\pi)CT$$

where C is the phase velocity, x the distance, T the period, t the travel time, N an integer, and φ_0 the initial phase of the travelling wave component. Since t and T may be measured from a record of the disturbance and x may be determined, the equation may be used to compute the phase velocity as a function of period, if the initial phases are known. If distance and the dispersion are known, initial phases may be determined. From distance, initial phases, and phase velocities, the disturbance at any point may be constructed. The practical use of the method is demonstrated by application to antisymmetric waves in a cylindrical rod, Rayleigh waves from United States and Russian nuclear explosions, Rayleigh waves from the Hudson Bay earthquake of January 30, 1959, and Love waves from the Fairview Peak and Fallon, Nevada, earthquakes of 1954.

534.2 : 550.3

RAYLEIGH TYPE WAVES IN THE VICINITY OF SMALL EXPLOSIONS. See Abstr. 10382

534.21

10715 MEANING AND INTERPRETATION OF ACOUSTIC MOMENTUM AND ACOUSTIC RADIATION STRESS.

E.J.Post.
Phys. Rev., Vol. 118, No. 5, 1113-18 (June, 1960).

Surveys viewpoints and available procedures of analysis of acoustic radiation stress and the concept of acoustic momentum. An alternative approach is suggested based on Eckart's principle and Poynting's condition of separate observability of matter and elastic wave motion. The results are consistent with those obtained by means of the adiabatic principle but show discrepancies with the so-called Eulerian approach for transverse waves. Radiation stress and radiation momentum are typical field concepts needed to complement the continuum description. In a sense they serve to establis consistency with the particle approach, thus filling a need which the conventional theory of elasticity does not satisfy. The energy momentum tensor of elastic wave motion provides a unique example of a physically meaningful space-time covariance in the framework of Galilean kinematics.

534.21

10716 TRANSIENT INTERACTION OF AN ACOUSTIC WAVE WITH A CIRCULAR CYLINDRICAL ELASTIC SHELL.

R.G.Payton.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 722-9 (June, 1960).

An infinitely long, circular cylindrical elastic shell is surrounded by an acoustic fluid. A plane pressure pulse, whose front is parallel to the axis of the shell, moves through the fluid, strikes the shell, and subsequently engulfs the shell. The circular shell is replaced by a fictitious Riemann surface which effectively allows the range of θ (the angular coordinate) to be extended from $-\infty$ to $+\infty$. Exact expressions are then found for the subsequent shell and fluid motion in the form of double integrals by the use of integral transform techniques. These integrals are evaluated asymptotically by the method of steepest descent to determine the early time motion of the shell and fluid. In particular, it is found that during this early motion the radial shell velocity and bending moment have a maximum, and the fluid pressure at the interface experiences a minimum.

534.21

10717 NOTE ON THE OPERATIONAL CHARACTERISTICS OF A ROD CONCENTRATOR. L.O.Makarov.

Akust. Zh., Vol. 5, No. 3, 372-4 (1959). In Russian. English translation in: Soviet Physics—Acoustics (New York), Vol. 5, No. 3, 380-2 (Feb., 1960).

The effect of the load on which the concentrator operates is taken into account and certain advantages of the exponential over the stepped half-wave concentrator are pointed out. J.Jarzynski

534.21 : 535.41

10718 A MOIRE FRINGE ANALOG OF SOUND PROPAGATION IN SHALLOW WATER. D.E.Weston.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 647-54 (June, 1960).

A moiré fringe analogue of the normal modes of sound propagation in shallow water is described, in which interesting patterns are obtained both by direct visual observation and by photographic recording. These are analogues for the profiles of sound pressure as a function of range and depth in the underwater field due to a single-frequency source. Since phase is correctly represented, the interaction patterns due to the presence of considerable numbers of interfering modes may be investigated experimentally. This is important since mathematical analysis becomes difficult when there are more than two modes. There is a discussion of the characteristics of these patterns (including the formation of "loops") and also of those obtained by Wood (Abstr. 13089 of 1959) in his sound propagation model experiments.

534.21

10719 PROPAGATION OF LOW-FREQUENCY CW SOUND SIGNALS IN THE DEEP OCEAN.

A.N.Guthrie, I.Tolstoy and J.Shaffer.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 645-7 (June, 1960).

The acoustic field of a 10 c/s c.w. source, towed at slow speeds at a depth of 24 m was measured by a stationary hydrophone out to ranges of about 70 km. The depth of the hydrophone was approximately 450 m. The records obtained are compared with theoretical calculations of the wave field, using a method developed by one of the authors. The degree of agreement is fair enough for one to feel that further work along these lines should lead to a quantitative understanding of long range sound propagation in the oceans.

534.21

10720 A NUMERICAL SOLUTION FOR THE PROBLEM OF LONG-RANGE SOUND PROPAGATION IN CONTINUOUSLY STRATIFIED MEDIA, WITH APPLICATIONS TO THE DEEP OCEAN. I.Tolstoy and J.May.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 655-60 (June, 1960).

Since the formal solution for guided waves excited by a point source in an arbitrarily stratified medium is well known, in the sense that it can be written down in terms of (unexplicited) eigenfunctions and their derivatives, it follows that evaluation of the long-range sound field becomes a purely computational problem once these eigenfunctions can be calculated. One of a number of possible methods is presented here. It consists of two steps. First, the continuous sound velocity, $\alpha(z)$, is approximated by a succession of layers such that α has the form $(pz + q)^{-1/2}$ in each: the exact wave functions for a layer are then known (combinations of Bessel functions of order $\pm\frac{1}{3}$). The second step, which puts this scheme within easy reach of moderately fast computers such as the IBM 650, consists in representing these wave functions by polynomials (argument of Bessel function $\leq 2.5\pi$) or by the first few terms of their asymptotic expansions (with better than six-figure accuracy in both cases). Accurate solutions are obtained in this manner without difficulty, for both strong or weak velocity gradients. Some typical results for a deep ocean are displayed. It is also shown that near field problems can be solved in the case of a source and receiver in, or near, a local velocity minimum or duct.

534.21 : 535.42

DIFFRACTION OF LIGHT BY A THREE-DIMENSIONAL SYSTEM OF ULTRASONICS. See Abstr. 8808.

534.22

10721 SPEED OF SOUND IN SEA WATER AS A FUNCTION OF TEMPERATURE, PRESSURE, AND SALINITY.

W.D.Wilson.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 641-4 (June, 1960).

Tables for the speed of sound in sea water are presented. These tables have been prepared from an empirical formula which was derived to fit measured sound-speed data obtained over the temperature range -3°C to 30°C, the pressure range 1.033 kg/cm^2 to 1000 kg/cm^2, and the salinity range $33\,^\circ/_{00}$ to $37\,^\circ/_{00}$. The discrepancy of -3.0 m/sec found by Del Grosso at 1 atm., as compared to the tables Kuwahara, is substantiated. In addition, the pressure coefficient of sound speed observed in the present work differs from that predicted by Kuwahara.

534.22 : 532.5

10722 INFLUENCE OF CHEMICAL VISCOSITY AND OF HEAT TRANSFER ON THE SPEED OF SOUND AND THE VELOCITY OF A STABLE FLOW AT A CONSTRICTION.

M.Serruys and P.Magot-Cuvrû.

C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3134-6 (May 9, 1960). In French.

The quantitative dependence of the velocity of sound in an expanding fluid on the reaction rate is derived. P.Gray

534.22

10723 ULTRASONIC PROPAGATION CONSTANTS IN SUPERCOOLED SALOL. S.Parthasarathy and V.N.Bindal.

Nature (London), Vol. 186, 145 (April 9, 1960).

Measurements are given of the ultrasonic velocity (at 6 Mc/s) and absorption (at 7.15 Mc/s) over the temperature range 35° to 58°C, discontinuities in both the ultrasonic velocity and the absorption were observed at the melting point. J.Jarzyński

534.22 : 532.7

10724 HYPERSONIC VELOCITY IN VISCOUS LIQUIDS AS REVEALED FROM BRILLOUIN SPECTRA. S.N.Sen.

Proc. Phys. Soc., Vol. 75, Pt 4, 612-16 (April 1, 1960).

Taking into consideration Lamb's theory for the propagation of high-frequency acoustical waves in viscous liquids, and the idea of Maxwell regarding complex viscosity, a theoretical expression was deduced for the velocity of high-frequency acoustical waves through viscous liquids. It is observed that if Frenkel's expression for the rigidity modulus of a liquid be introduced into the formula for wave propagation, then the theoretical formula explains the dispersion of sound velocity in viscous liquids observed by Venketeswaran from Brillouin spectra and the theoretical value is in good agreement with the experimental result. Further, the introduction of complex viscosity partly explains the propagation of these high-frequency waves through viscous liquids.

534.22

10725 MEASUREMENTS ON THE BLAST WAVE IN A CONICAL TUBE. W.S.Filler.

Phys. of Fluids, Vol. 3, No. 3, 444-8 (May-June, 1960).

Spherical high-explosive blast waves were studied under simplified laboratory conditions using a sector shock tube and detonating at its apex a high explosive. In the experiment, a quantity of explosive equivalent in energy to $\frac{1}{2}$ g of TNT was used. Pressure-time histories of the shock waves produced in the cone were obtained with piezoelectric gauges. These waves were shown to possess the typical features of spherically expanding blast waves. The magnitudes of the peak pressures, positive durations, and impulses of the shock waves were found to be characteristic of those produced by spherical charges of about 60 times the weight of explosive actually used. This falls short of the design amplification of the 22° cone used by about 40%. However, amplification effects larger by several orders of magnitude appear possible with the use of cones having smaller angles.

534.22 : 538.3

STRUCTURE OF A SHOCK WAVE IN MAGNETOHYDRODYNAMICS. See Abstr. 9178

534.22

10726 PASSAGE OF SHOCK WAVES THROUGH DUCTS OF VARIABLE CROSS SECTION. G.Rudinger.
Phys. of Fluids, Vol. 3, No. 3, 449-55 (May-June, 1960).

If shock waves strong enough to produce supersonic flow pass through a duct of variable cross-section, the shape of which is approximated by a single discontinuous area change, a variety of wave patterns may be found. These are unique for particular conditions except for a range of area convergence for which it was recently shown that three solutions exist. Examination of the transient processes that precede the establishment of the final flow suggests, and a general proof confirms, that only one of these solutions can actually be realized if the duct converges monotonically. For more general duct configurations, the other solutions may also be found, but the correct wave pattern may have to be established with the aid of a wave diagram in which area changes are properly taken into account. For configurations with a throat, additional wave patterns may appear both within and outside of the region of ambiguity which then loses its significance.

534.22 : 536.5

10727 MEASUREMENT OF THE GAS TEMPERATURE BEHIND A SHOCK WAVE. S.A.Losev and N.A.Generalov.
Pribory i Tekh. Eksper., 1959, No. 3, 108-10 (May-June). In Russian.

A method of measuring the gas temperature, using the emission intensity and the absorptive power of the D-lines of sodium, is applied to measurements behind a strong shock wave. To observe absorption a pulse lamp IPS-500 was employed. Temperatures up to 4000-5000° K could be measured with an accuracy of 100-200° K.
A.Tybulewicz

534.22 : 539.18

10728 RADIATIVE PROCESSES AHEAD OF A SHOCK-WAVE FRONT. L.M.Biberman and B.A.Veklenko.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 164-9 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 117-20 (Jan., 1960).

The distribution of excited atoms or molecules ahead of a shock-wave front is considered. The excitation is produced by radiation coming from the shock front. The process of non-stationary diffusion of the radiation is taken into account. It is shown that concentrations of excited atoms or molecules corresponding to excitation temperatures close to the temperature of the shock wave are formed in the cold gas ahead of the wave front.

534.22

10729 BIMODAL MODEL FOR SHOCK WAVE STRUCTURE. C.Muckenfuss.
Phys. of Fluids, Vol. 3, No. 2, 320-1 (March-April, 1960).

The bimodal model, which derives the velocity distribution from the weighted sum of two Maxwellian distributions, ahead of and behind the shock, is used to obtain thicknesses of shock fronts in argon. Results are compared with those given by the Navier—Stokes equation and with some published experimental data. A.G.Gaydon

534.22

10730 SHOCK CONDITIONS IN A FLUID WITH SMALL BUT NON-ZERO COEFFICIENTS OF VISCOSITY AND THERMAL CONDUCTIVITY. P.Germain and J.P.Guiraud.
C.R. Acad. Sci. (Paris), Vol. 250, No. 11, 1965-7 (March 14, 1960). In French.

Formulates a set of first-order correction terms for the shock equations of a "perfect" fluid, and outlines their derivation.
H.N.V.Temperley

534.22 : 536.46

PRE-DETONATION MECHANISM OF FLAME PROPAGATION IN ROUGHENED TUBES. See Abstr. 10809

534.22 : 541.12

INVESTIGATION OF DETONATION WAVE PRESSURE BY A CRUSHER ROD COMPRESSION METHOD. See Abstr. 10351

534.23

10731 MEASUREMENTS OF THE TOTAL ACOUSTIC RADIATION IMPEDANCE OF RIGID PISTONS IN AN ARRAY. J.S.M.Rusby.
Nature (London), Vol. 186, 144-5 (April 9, 1960).

Measurements were made using arrays of ammonium dihydrogen phosphate crystal projectors. For projectors in an array where each plays an identical role (e.g. one, two, a square of four etc.) the admittance diagrams were found to be circles. Near the resonant frequency of 18 kc/s the measured admittance diagram of a particular projector in a 6 × 6 square was found to be exceedingly complicated indicating rapid variations of the radiation impedance. A preliminary theory is given. J.Jarzynski

534.23 : 534.22

10732 ABSORPTION OF SOUND AND THE WIDTH OF SHOCK WAVES IN RELATIVISTIC HYDRODYNAMICS. M.T.Zhumartbaev.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1000-4 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 711-13 (April, 1960).

The absorption coefficient of sound due to viscosity and heat conduction of the medium is derived in relativistic hydrodynamics. The structure of relativistic low-intensity shock waves is considered.

534.23

10733 ABSORPTION OF ULTRASONIC WAVES IN CRYSTAL QUARTZ AT FREQUENCIES UP TO 1000 Mc/s. L.G.Merkulov and L.A.Yakovlev.
Akust. Zh., Vol. 5, No. 3, 374-6 (1959). In Russian. English translation in: Soviet Physics—Acoustics (New York) Vol. 5, No. 3, 383-4 (Feb., 1960).

Measurements were made with shear and longitudinal waves propagated along the x-, y- and z- axes in the temperature interval -200° to 200°C. Comments are made on the observed slight dependence of the absorption on the direction of propagation, wave type and temperature. J.Jarzyński

534.23 : 536.48

ULTRASONIC ABSORPTION IN SUPERCONDUCTING AND NORMAL MERCURY. See Abstr. 8954

534.26

10734 CONSIDERATION OF REFLECTION AT THE RADIATOR IN THE THEORY OF AN ULTRASONIC INTERFEROMETER. V.A.Solov'ev.
Akust. Zh., Vol. 5, No. 3, 382 (Feb., 1959). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 5, No. 3, 392-3 (Feb., 1960).

It is pointed out that a more rigorous treatment is still in agreement with Hubbard's theory. J.Jarzynski

534.6

10735 ON THE TRANSFORMATION FROM AN ULTRASONIC TO A VISUAL IMAGE. V.G.Prokhorov.
Akust. Zh., Vol. 5, No. 3, 379-80 (1959). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 5, No. 3, 389-90 (Feb., 1960).

The author replies to criticisms in Yu.B.Semennikov's paper "An investigation of an electron-converter" (see Abstr. 6761 of 1958), wherein the latter asserts that the equivalent circuit of the converter given by Prokhorov, and his analysis of its sensitivity, are incorrect. C.F.Pizzey

534.6

10736 ON THE TRANSFORMATION FROM AN ULTRASONIC TO A VISUAL IMAGE. Yu.B.Semennikov.
Akust. Zh., Vol. 5, No. 3, 381 (1959). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 5, No. 3, 390-1 (Feb., 1960).

Semennikov considers Prokhorov's reply (see preceding abstract), and agrees that a correct value of the conversion coefficien will be given by Prokhorov's equivalent circuit for low values of load and beam current, but maintains that phase relations between excitation and output potentials will always be incorrect. He also states that Prokhorov has introduced a resonant loop into the circuit which did not appear in his original paper. C.F.Pizzey

534.6

10737 TEST SETUP FOR MICROPHONE CALIBRATION. W.F.Cox.
J. Acoust. Soc. Amer., Vol. 32, No. 4, 508-9 (April, 1960).

Describes a comparison method of calibrating microphones. The "test" and "standard" are arranged to receive the same sound signal from a loud-speaker, and the received signals are displayed in amplitude and phase on a dual beam c.r.o., the sweep-synchronization being supplied from the source of power supply to the loudspeaker. The "automated" display gives "quick-look" data on distortion, phase and amplitude. A block diagram illustrates the method. A.B.Wood

534.6 : 621.317.74 : 621.395.61

10738 HIGH-INTENSITY SOUND REVERBERATION CHAMBER AND LOUDSPEAKER NOISE GENERATOR.

W.T.Fiala and J.K.Hilliard.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 269-72 (March, 1959).

A high-intensity sound test chamber capable of producing 145 dB and having a working area of 6 × 3 × 1½ ft is described. The chamber uses the principle of reverberant sound to test electronic packages used in aircraft and missiles. Double-wall construction and use of Aquaplas for panel damping provides the necessary sound insulation. Complete instrumentation and the loudspeaker generator are described.

534.8 : 538 : 621.317.44

MAGNETIC FIELD MEASUREMENT USING ULTRASONICS.

See Abstr. 11010

534.81

10739 PRESENTATION OF A GENERAL GRAPH OF ACOUSTIC VALUES. J.Bogaert.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 8, 804-18 (1959). In French.

The notes of various musical scales are plotted as deviations in cents from the theoretical equal-tempered scale. H.D.Parbrook

534.83

10740 EVALUATION OF NOISES.

E.Lübcke.

Frequenz, Vol. 13, No. 9, 287-9 (Sept., 1959). In German.

Reference is made to the use of the D.I.N. loudness meter (D.I.N. 5045) for the arrangement of noises (sounds) according to sound level. A table gives the results of octave band measurements 100-200, 150-300, 200-400 and 300-600 c/s, indicating a slope of 6 dB/octave for the lower-octave range. See also Akust. Beih., Vol. 9, No. 1, 243-6 (1959). A.B.Wood

534.83

10741 ON THE EFFECT OF MISSILE MOTION ON ROCKET NOISE. A.Powell.

J. Acoust. Soc. Amer., Vol. 30, No. 11, 1048 (Nov., 1958).

On the assumption that turbulent mixing accounts for the major part of rocket noise, it is tentatively suggested that the rocket noise intensity at a given point on a missile varies as

$$\left[\frac{M_j - M_m}{M_j}\right]^3 (1 - M_m)^2$$

where M_j is the highly supersonic Mach number of the jet efflux relative to the exit, and M_m is the subsonic Mach number of the missile, both referred to the speed of sound in the external air. The frequency characteristics are little affected.

534.84

10742 DEPENDENCE OF SOUND ABSORPTION COEFFICIENTS UPON AREA OF ACOUSTICAL MATERIAL.

G.Gifford and A.Muehlhausen.

J. Acoust. Soc. Amer., Vol. 32, No. 6,773 (June, 1960).

The theoretical basis for area correction curves in reverberation chambers was presented by Northwood (Abstr. 6667 of 1959). Data are presented which agree with Northwood's article, but disagree with many area correction curves measured in the past.

534.84

10743 AUDIENCE AND SEAT ABSORPTION IN LARGE HALLS.

L.L.Beranek.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 661-70 (June, 1960).

From detailed acoustical studies made in over 40 large concert halls and opera houses in 15 countries, absorption coefficients are derived for audience, chorus, and orchestra areas, unoccupied seating areas, plaster walls and wood walls. It is postulated that the absorbing power of a seated audience, chorus or orchestra in a large hall is proportional to the floor area it occupies. This postulate is validated for audience densities of between 4.5 and 8.5 sq. ft. per person, including aisles, and for halls with volumes between 200 000 and 1 500 000 cu. ft. The "area" concept as opposed to the "per person" concept of audience absorption explains the serious differences reported repeatedly in the literature between reverberation times calculated during design and those measured after completion of the halls. This paper also presents graphical relations between empty and fully occupied hall reverberation times; shows the effect of seat design on empty hall reverberation times; and gives typical reverberation time versus frequency characteristics for fully occupied halls. The results of this study may not be applicable to rooms whose volume, shape, and materials are substantially different from the large concert halls and opera houses included in this study.

534.85

19744 DISCUSSION ON "LISTENER REACTION TO STEREOPHONIC REPRODUCTION BY REFLECTED SOUND".

P.W.Klipsch.

J. Acoust. Soc. Amer., Vol. 32, No. 4, 509 (April, 1960).

After discussing the requirements of stereophonic high fidelity sound, the author states that his experiments indicate that fidelity of geometry and tonality require a collinear display of 3 widely spaced loudspeakers with 3 channels, either independent or with derived centre channel. All other configurations have failed to afford fidelity, each lacking something in either tonality or geometry. A.B.Wood

OPTICS . PHOTOMETRY

535.1

10745 POLARIZATION AND RESOLVING TIME EFFECTS IN PHOTON CORRELATION. E.Brannen and W.Wehlau.

Nature (London), Vol. 184, 263-4 (July 25, 1959).

The effects of polarization and variation of the resolving time in experiments on the correlation of the arrival of photons at detectors in coherent beams are reported to be in agreement with theoretical predictions. W.T.Welford

535.22

10746 THE SPEED OF LIGHT IN AIR AND IN VACUUM.

R.Dupeyrat.

J. Phys. Radium, Vol. 19, No. 5, 557-69 (May, 1958). In French.

Since 1950, the velocity of propagation of electromagnetic waves in vacuum has been taken as approximately 299 793.1 km/s, the error being less than 1 km/s. Experiments which are now in course should give a much better precision (0.01 km/s). In this paper, the methods of measurement selected are classified according to the nature of the measured velocity: direct measurements (in air, group or signal velocity; in a vacuum, phase velocity), indirect measurements (generally, interferential measurements of phase velocity). In the opinion of the author, there is no point in taking a weighted mean as has been done in most of the recent reviews. The collected results may raise the question of changing the fundamental units of the systems.

535.24 : 536.3

DETERMINATION OF SPONTANEOUS PHOTON FLUCTUATIONS.

See Abstr. 8830

535.24

10747 LIGHT COLLECTION AND ABSOLUTE CALIBRATION OF EXTENDED SOURCES. R.A.Young.

J. Opt. Soc. Amer., Vol. 50, No. 6, 627-8 (June, 1960).

In order to collect after-glow from several litres of nitrogen the containing flask was coated with MgO to form an integrating sphere. The absolute efficiency was determined. W.T.Welford

535.24

10748 PHOTOELECTRIC COMPARATOR FOR RAYLEIGH FRINGE ELECTROPHORESIS PATTERNS.

C.C.Curtain.

J. sci. Instrum., Vol. 37, No. 6, 190-3 (June, 1960).

A photoelectric fringe comparator for scanning electrophoresis plates, based on a microdensitometer, a Schmitt-trigger operated counter and a recording milliammeter is described. The basis of the microdensitometer is a standard Zeiss binocular microscope with a mechanical stage driven by a reduction gearbox. A considerable simplification in the electronic circuit of the densitometer is achieved by using highly sensitive type ORP 90 cadmium sulphide photoconductive cells.

GEOMETRICAL AND INSTRUMENTAL OPTICS

SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

535.31

10749 THE INFLUENCE OF COMA ON THE RESPONSE FUNCTION OF AN OPTICAL SYSTEM. A.M.Goodbody.
Proc. Phys. Soc., Vol. 75, Pt 5, 677-88 (May, 1960).

The treatment used in a previous paper dealing with the effect of spherical aberration on optical response functions (Abstr. 170 of 1959) was extended to cases of coma, an aberration which is not an even function in the pupil coordinates x and y, and consequently gives rise to lateral shifting in the image. Different positions of the focal plane, the state of correction for higher-order aberration, and different azimuths of the line structure in the object are considered. Detailed results are given first for primary circular coma, when the wavefront aberration coefficient has the values $w_{31} = +0.63$, $+1.26$ and $+1.89$ wavelengths: three focal planes and the azimuths $\psi = 0$ (radial lines) and $\psi = \pi/2$ (tangential lines) are treated. Results are also given for secondary coma for the values $w_{51} = -2.6$, -3.9, -5.85 and -7.8 wavelengths, with three different states of correction and again in three focal planes and two azimuths. It is found with negative values of w_{51} that the relative phase shifting of frequency components within the image has no appreciable effect on the image quality in the cases considered when this negative secondary come is compensated with a suitable numerically larger positive primary coma ($w_{31} + w_{51} > 0$), if focal planes situated a long way from the paraxial focal plane are accepted.

535.31

10750 THE INFLUENCE OF ABERRATION AND DETECTOR RESPONSE ON OPTICAL IMAGES. F.A.Dixon.
Proc. Phys. Soc., Vol. 75, Pt 5, 713-28 (May, 1960).

The optical-frequency response function is used to obtain the intensity distribution in the image of a step function of intensity, and from this the image intensity distributions for strips and Cobb test units are obtained. Detectors having a Gaussian type response function of different equivalent bandwidths s_0 are assumed. The treatment is applied to systems having secondary spherical aberration of amounts $W_{60} = -6\lambda$, -9λ, -12λ, with different amounts of primary spherical aberration and several planes of focus in each case, and for a range of values of s_0, the equivalent bandwidth of the detector. From these calculations the edge gradient in the image of a step function of intensity, the limit of detection and the limit of resolution, using a criterion of 0.2 for the necessary image contrast, are found; these different methods for the assessment of optical systems are then intercompared. It is shown for example that if two systems are assessed by two different test methods the order of the figure of merit for the two systems can be significantly different, and furthermore the order of merit in which the two systems are placed depends strongly on the response function of the detector employed. The differences are large enough to be of real significance in practice. It is generally known from qualitative considerations of optical image formation that when the detector employed has a narrow bandwidth the shape of the frequency response function is of greater importance for low values of the spatial frequency s, the response function for higher spatial frequencies having little influence on the image quality while for a system employing a detector of wide bandwidth the shape of the frequency response function for the higher frequencies is important, as these frequencies can now contribute to the formation of the image. An attempt has been made to study quantitatively the effect of detector bandwidth on the formation of the images of some standard test objects.

535.31

10751 OPTICAL ABERRATION COEFFICIENTS. VIII. COEFFICIENT OF SPHERICAL ABERRATION OF ORDER ELEVEN. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 50, No. 7, 678-83 (July, 1960).

For Pt VII, see Abstr. 8775 of 1960. On the occasion of developing the theoretical basis for the calculation of the coefficient of quaternary spherical aberration it was suggested that it would be desirable to proceed to coefficients of still higher order for the purpose of obtaining a heuristic basis for the study of the behaviour of the power series of geometrical optics. With this end in view the present paper deals with the derivation of all the relations and expressions required for the computation of the coefficient of quinary (eleventh order) spherical aberration. A complete numerical example is provided as usual. Some preliminary consideration is given to the behaviour of certain power series.

535.8

10752 AN INTERFERENCE MICROSCOPE ARRANGEMENT FOR ABSOLUTE STUDIES WITH INCIDENT ILLUMINATION. G.Schulz.
Optik, Vol. 17, No. 1, 25-33 (Jan., 1960). In German.

An interference microscope is described which does not employ a reference surface. Varieties of lens systems are discussed for the design of a suitable interference microscope. S.Tolansky

535.8

10753 A PHOTOELECTRIC DEVICE FOR SETTING A MEASURING MICROSCOPE.
H.M.Davis and W.H.Lockwood.
Brit. Commun. and Electronics, Vol. 5, No. 12, 982-5 (Dec., 1958).

An improved method is described for measuring and presenting spectral lines in emission spectroscopy. The system utilizes a measuring microscope, a scanner and a cathode-ray tube display unit. Apart from its use in emission spectroscopy, it is suggested that the apparatus can also be adapted for the examination of Schlieren photographs and for the measurement of "powder" photographs in X-ray diffraction work.

535.8 : 536.52

ABSORBING FILTERS AND HIGH-TEMPERATURE OPTICAL PYROMETRY. See Abstr. 10812

535.8

10754 A NEW METHOD OF MEASURING THE REFLECTION COEFFICIENT. F.Lukeš.
Czech. J. Phys., Vol. 9, No. 1, 118-23 (1959). In Russian.

A beam from a monochromator slit is first reflected by a concave mirror Z_0 and then it is either (1) reflected from a plane aluminized mirror Z_1 and proceeds to a detector D (intensity at the detector is I_1); (2) reflected successively from a sample Z, and from two plane aluminized mirrors Z_3 and Z_2 (intensity at the detector is I_2); or (3) reflected successively from Z_2, Z_3 and Z_2 (intensity at the detector is I_3). Assuming that the reflection coefficients of the aluminized mirrors are equal, the reflection coefficient of the sample is given by $r = (I_2^2/I_1I_3)^{1/2}$. The method is illustrated by measuring the reflection coefficient of germanium in the ultraviolet and visible regions. A.Tybulewicz

535.8

10755 THE FIELD DISTRIBUTION IN OPTICAL WAVEGUIDES. B.S.Skorobogatov.
Optika i Spektrosk., Vol. 7, No. 6, 832-3 (Dec., 1959). In Russian.

A source is placed at a large distance from a plane optical waveguide and, by selecting the angle of incidence of a parallel beam on the entry slit, waves of various orders can be excited in the waveguide. For excitation of waves of one order the angle of incidence i must obey the relationship $\cos i = c/v$, where c is the velocity of light and v is the phase velocity. This is confirmed experimentally by showing that at the angles of incidence obeying the cosine relationship the field distribution in the waveguide agrees very well with the theoretical distribution expected for a wave of a given order. At other angles of incidence waves of two neighbouring orders are excited, whose relative intensities can be determined from the resultant diffraction pattern. A.Tybulewicz

535.8

10756 DIFFRACTION AT THE EXIT OF AN OPTICAL WAVEGUIDE. B.S.Skorobogatov.
Optika i Spektrosk., Vol. 7, No. 6, 823-4 (Dec., 1959). In Russian.

Deals with diffraction of monochromatic light at the exit slit of a plane optical waveguide under the conditions of symmetric and asymmetric excitation. In the case of symmetric excitation two coherent beams fall on the entry slit of the guide at angles of θ and $-\theta$ and the diffraction pattern at the exit slit is independent of the length f the waveguide (periodic dark bands in the pattern disappear when white light is used). In the case of asymmetric excitation a single monochromatic beam falls obliquely on the entry slit of the guide and the diffraction pattern at the exit slit depends on the length of the waveguide and becomes symmetric only at a certain value of this ength; intensities at the minima in the diffraction pattern are not equal to zero. A.Tybulewicz

535.8

10757

IMAGE INTENSIFICATION BY TRANSMISSION SECONDARY ELECTRON EMISSION.

M.M.Wachtel, D.D.Doughty, G.Goetze, A.E.Anderson and E.J.Sternglass.

Rev. sci. Instrum., Vol. 31, No. 5, 576-8 (May, 1960).

Describes the construction and performance of image intensifying tubes using an Sb–Cs photocathode and a set of Al–BaF$_2$ dynodes supported on reinforcement grids. The half-life of this type of dynode is about 5 times greater than that of a KCl dynode operated under the same conditions; these tubes are thus preferable for applications requiring longer exposures. C.H.B.Mee

535.8 : 531.71

10758

SEALED-OFF Hg^{198} ATOMIC-BEAM LIGHT SOURCE.

R.L.Barger and K.G.Kessler.

J. Opt. Soc. Amer., Vol. 50, No. 7, 651-6 (July, 1960).

A sealed-off atomic-beam light source which utilizes the single isotope Hg^{198} is described. The emitted 2537 A line was investigated interferometrically with Fabry–Perot interferometers. Interferograms are shown for retardations of 0.4, 1.53, and 2.04 m with order numbers 1.6, 6.0, and 8.1 million, respectively. For each retardation, the theoretical contour of the observed fringes is shown. Theoretically predicted fringe contours are shown for retardations up to 6 m, the approximate limit of interface. It is concluded from the interferograms that the Hg^{198} 2537 A line has a half-width of 0.0016 cm^{-1}, as compared to 0.012 cm^{-1} for the Kr^{86} 6056 A line proposed as the new primary standard of length. Owing to the small half-width and the extremely low level of perturbation in the atomic beam, this Hg^{198} line would be suitable for the primary standard of length.

535.8

10759

LABORATORY SUN.

J.F.Elliott, R.E.Hysell and V.Meikleham.

J. Opt. Soc. Amer., Vol. 50, No. 7, 713-17 (July, 1960).

Davis and Gibson liquid filters and a tungsten lamp are used to provide a radiation source that approximates the sun's irradiation and spectral distribution. The source is particularly useful for investigations of photovoltaic solar energy converters.

535.33

10760

PRINCIPLE AND REALIZATION OF A NEW TYPE OF INTERFERENCE SPECTROMETER.

P.Connes.

Rev. Opt., Vol. 38, No. 4, 157-201 (April); No. 9-10, 416-46 (Sept.-Oct., 1959). In French.

A gain in performance and light collection is secured by replacing the mirrors of a Michelson interferometer by prisms or gratings. By turning these or by altering path differences, full theoretical resolving power and high light collection are secured. The instrument is very useful in the infrared, acting as a modulator, not as a monochromator. Modulation is produced by a saw-tooth rotation of the compensation plate. The performance of an instrument is described and design tolerances are discussed. Experimental resolution and luminosity are effectively those predicted theoretically. Double-beam systems are discussed, especially in connection with elimination of modulation noise. S.Tolansky

535.33 : 522.5

10761

A HIGH-DISPERSION PHOTOELECTRIC SPECTROPHOTOMETER.

J.B.Rogerson, L.Spitzer and J.D.Bahng.

Astrophys. J., Vol. 130, No. 3, 991-1002 (Nov., 1959).

Photoelectric equipment has been successfully used for high-dispersion spectrophotometry at the 100 in. telescope. The intensity in the spectrum was measured by the ratio of photon counts obtained by two photocells, one fixed, the other scanning the spectrum. Successful seeing compensation was achieved by using phototubes with a sensitivity that was relatively uniform spatially and by focusing a very small (1.3 mm) light-spot on the photocathode. With an exit slit 0.12 A wide, the intensity observed in repeated scans, with counts of 1 or 2 minutes duration at each wavelength, has a non-statistical fluctuation averaging 0.6 per cent under good conditions; the fluctuation in the two channels separately amounts to about 8%. The statistical accuracy is limited by the low quantum efficiency of the telescope-spectroscope-photometer combination, with only one photon counted in every 5000 — a loss of 9.3 mag. A more efficient image slicer, a more sensitive phototube, and more careful attention to reflection losses could yield a gain of 3-4 mag.

535.33

10762

AN ATTACHMENT TO AN SF-4 SPECTROPHOTOMETER FOR RECORDING LUMINESCENCE SPECTRA.

A.P.Kilimov, L.L.Nagornaya and B.A.Zadorozhnyĭ.

Pribory i Tekh. Eksper., 1959, No. 3, 105-7 (May-June). In Russian.

Describes a simple photomultiplier attachment which can be used to measure the luminescence spectra of liquids or solids in the 330-550 mμ region. Measurement of the spectral sensitivity is described and the recording procedure is given. The recorded luminescence spectra of phenanthrene, tetraphenylbutadiene and naphthalene agreed with those reported by other workers. A.Tybulewicz

535.33 : 77

MEASURING SPECTRAL TRANSMITTANCES OF PHOTOGRAPHIC OBJECTIVES WITH THE CARY MODEL 11 MS RECORDING SPECTROPHOTOMETER.

See Abstr. 10790

535.33

10763

THE NOISE/SIGNAL RATIO OF DOUBLE-BEAM INFRARED SPECTROMETERS.

L.A.Gribov.

Pribory i Tekh. Eksper., 1959, No. 3, 102-5 (May-June). In Russian.

Dependence of the noise/signal ratio on the parameters of the amplifier-recorder system is obtained for double-beam null-method infrared spectrometers. The resolving power of the recorder is estimated. A.Tybulewicz

535.33

10764

COMMENT ON INTERFEROMETRIC SPECTRAL ANALYZERS.

L.Mertz.

Astrophys. J., Vol. 131, No. 2, 519 (March, 1960).

In reply to F.D.Kahn's evaluation of the method (Abstr. 10750 of 1959) the merits of interferometric analysis are emphasized as follows : (1) advantage of a large reception angle ; (2) ease of construction compared with scanning spectrometers ; (3) dark current effects in photoreceiver are minimized ; (4) background spectrum of the night-sky may be directly subtracted even though its noise remains. A disadvantage of the method however, is the necessity to subject all the derived data to a Fourier transformation in order to reveal the spectrum. D.R.Barber

535.33

10765

CONTRIBUTIONS TO THE THEORY OF THE VOLUME RADIATOR WITH PARTICULAR REFERENCE TO MICROTECHNIQUES [IN RAMAN SPECTROSCOPY].

F.Dullien.

Acta phys. Hungar., Vol. 7, No. 2, 181-7 (1957). In German.

Using geometrical optics it is shown that for Raman spectroscopy equally good light conditions can be obtained with a long scattering tube (Wood's tube) with cross-sectional dimensions about equal to those of the collimator slit as with a conventional broad tube, provided the refractive index of the liquid under test is not much greater than that of the tube material. Experimental tests made with a capillary tube of about 1 mm light width and 250 mm length are described and show that the signal to noise ratio is similar to that for a conventional tube, but that for liquids of refractive index less than that of the tube material a 60% reduction in signal to noise ratio could be obtained. S.Weintroub

535.33

10766

SPECTRAL ANALYSIS OF SOLUTIONS WITH TWO ROTATING ELECTRODES.

W.Guttmann, H.Becker and G.Müller-Uri.

Naturwissenschaften, Vol. 47, No. 6, 128-9 (1960). In German.

Spraying a solution into a glow discharge between two electrodes, both rotating, gives a method which is sensitive and reproducible. G.F.Lothian

535.33

10767

PRECISION MEASUREMENT OF THE WAVELENGTHS OF INFRARED ABSORPTION LINES WITH DIFFRACTION GRATINGS.

D.H.Rank.

J. Opt. Soc. Amer., Vol. 50, No. 7, 657-9 (July, 1960).

The use of modern diffraction gratings and photoconducting detectors makes possible the measurement of the wavelengths of infrared absorption lines to a precision amounting to a small fraction of the Doppler breadth of the lines themselves. The main difficulties encountered in making measurements to this precision seem to be in the scanning and interpolation procedures plus displacement errors arising from inexact superposition of known wavelengths on the spectrum to be measured. Making use of absorption lines as standards and a single light source eliminates displacement errors. Proper scanning techniques can reduce interpolation errors to insignificance. Coarse blazed gratings of very high degree of perfection are now available. Making use of the method of coincidence in high orders, such gratings can be used to effectively multiply the small number of accurately measured absorption lines available, so that only short interpolations between standard lines are necessary throughout the 1 to 4 μ region.

535.33

10768 RAPID PRECISION WAVE NUMBER MEASUREMENTS FROM FABRY—PEROT INTERFEROGRAMS.

D.W.Steinhaus.

J. Opt. Soc. Amer., Vol. 50, No. 7, 672-5 (July, 1960).

In order to obtain the more accurate wave numbers needed for studies of the very rich heavy element spectra, a new measuring and calculating procedure has been developed. A modern sharp line source, such as a hollow cathode discharge or an electrodeless metal-halide lamp, is used to illuminate a vacuum Fabry—Perot interferometer (5, 10, or 20 mm spacer). The interferometer is crossed with a spectrograph resolving the free spectral range of the interferometer. The resulting interferogram is measured with a two-coordinate photoelectric comparator. The measurements are punched on I.B.M. cards, and vacuum wave numbers are directly calculated with a high-speed digital computer. Only one standard line is needed and the index of refraction of air correction is used only to obtain air wavelengths. The phase change correction is obtained from measurements with two different spacers or from measurements on several standard lines. Only a few minutes reading time are needed for each line. This procedure is being used for a further study of the uranium spectrum with sources containing separated uranium isotopes. Over 8000 lines near 4100 A have been measured with a precision better than 0.005 cm^{-1}.

535.33 : 551.5

10769 ULTRAVIOLET SPECTRAL ENERGY DISTRIBUTIONS OF NATURAL SUNLIGHT AND ACCELERATED TEST LIGHT SOURCES.

R.C.Hirt, R.G.Schmitt, N.D.Searle and A.P.Sullivan.

J. Opt. Soc. Amer., Vol. 50, No. 7, 706-13 (July, 1960).

A contributory factor to the failure of correlation between outdoor and indoor photodecomposition tests is the difference in the ultraviolet spectral energy distributions of natural sunlight and the various indoor test sources which do not duplicate sunlight and differ widely among themselves. The ultraviolet spectral energy distributions of natural sunlight and of a variety of indoor exposure test sources have been measured. By use of a ferrioxalate actinometer, the measurements have been put on an absolute basis permitting the intercomparison of the sources. The xenon arc was found to be the best approximation of sunlight in the ultraviolet. For shorter wavelength ultraviolet (below 3500 A), the combination of fluorescent Sunlamp and Blacklight lamps also approximated sunlight.

535.33

10770 THE EFFECT OF SCANNING AND SELECTION OF THE OPTIMUM MEASUREMENT CONDITIONS. G.G.Petrash.

Optika i Spektrosk., Vol. 8, No. 1, 122-3 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the Theory of Spectroscopic Instruments (Leningrad, March 5-7, 1959). Fourier analysis is used to study systematic distortions in a spectrum $\varphi(\lambda)$ due to a spectral instrument as a whole (i.e. both the monochromator and the recording system). A.Tybulewicz

535.33

10771 THE INTERFERENCE—MODULATION METHOD. V.M.Arkhipov.

Optika i Spektrosk., Vol. 8, No. 1, 124-5 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the Theory of Spectroscopic Instruments (Leningrad, March 5-7, 1959). Discusses the relationship between the theoretical resolution due to a dispersing element (a diffraction grating) and the theoretical resolution of an instrument in which interference modulation is used. A.Tybulewicz

535.33

10772 CONCERNING THE LOSS OF LIGHT IN SPECTROGRAPH BY DIFFRACTION. J.Junkes.

Atti Fond. Ronchi, Vol. 15, No. 2, 152-60 (March-April, 1960).

When the slit of a spectrograph is illuminated by coherent radiation, a certain amount of energy is lost by diffraction; this loss increases in inverse proportion to the width of the slit. From the diffraction image of the slit in the focal plane, as well as from the pattern of Fresnel diffraction on the collimator, it can be deduced that this relative loss amounts to:

$$1 - \frac{2}{\pi}\left[\mathrm{Si}\,(2\,u_0) - \frac{\sin^2 u_0}{u_0}\right],$$

when the width s of the slit is expressed by: $2\,u_0 = \pi\lambda^{-1}.\,af^{-1}.\,s$.

535.33

10773 SPECTRUM LINE DISTORTION CAUSED BY STEP FILTERS. T.P.Schreiber, R.F.Majkowski and B.W.Josep

Appl. Spectrosc., Vol. 14, No. 2, 57 (1960).

Spectrum distortion results from step filter interference fringes which occur within the filter itself. Slight misalignment of the face of the filter avoids this distortion. G.I.W.Llewelyn

535.33

10774 RESOLUTION OF A MONOCHROMATOR WITH PHOTOELECTRIC RECORDING.

G.M.Malyshev, V.B.Skidan, É.E.Fradkin and M.P.Chaika.

Optika i Spektrosk., Vol. 7, No. 6, 780-4 (Dec., 1959). In Russian.

A method is given for determination of slit widths which ensure the best possible resolution of two monochromatic lines of the same intensity. It is assumed that the light source intensity and the characteristics of the spectrometer are constant, and that illumination in the focal plane of the monochromator is governed by diffraction at the entry split regarded as a rectangular aperture. Nomograms are given which help in these calculations. A.Tybulewicz

535.33

10775 THE INSTRUMENT FUNCTION OF A FABRY—PEROT SPECTROMETER WITH A RECTANGULAR APERTURE.

R.I.Semenov, É.E.Fradkin and M.P.Chaika.

Optika i Spektrosk., Vol. 7, No. 6, 785-8 (Dec., 1959). In Russian.

In optical measurements with a Fabry—Perot spectrometer it is necessary to know the distortions due to the presence of a diaphragm which is usually circular. The transmission function for a rectangular diaphragm and the instrument function of a Fabry—Perot spectrometer which uses this diaphragm, are derived. As in the case of a circular diaphragm, the energy maximum through a rectangular diaphragm does not coincide with the illumination maximum at the centre of the interference pattern. The displacement of the energy maximum has the same direction for both circular and rectangular apertures but it is smaller in the latter case. The asymmetry and width of the instrument functions of Fabry—Perot spectrometers with circular and rectangular diaphragms and the contrast produced by such spectrometers are discussed. A.Tybulewicz

535.33

10776 SCANNING DISTORTIONS WITH SINGLE-BEAM SPECTROMETERS. O.D.Dmitrievskii and V.A.Nikitin.

Optika i Spektrosk., Vol. 8, No. 1, 120-1 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the Theory of Spectroscopic Instruments (Leningrad, March 5-7, 1959). Scanning distortions of Gaussian-shaped lines and bands are discuss and theoretical formulae are found to agree with experiment in the case of IKS spectrometers. A.Tybulewicz

535.33

10777 MEASUREMENTS WITH DOUBLE-BEAM SPECTROPHOTOMETERS. L.A.Gribov.

Optika i Spektrosk., Vol. 8, No. 1, 123 (Jan., 1960). In Russian.

A summary of a paper presented at the Conference on the Theory of Spectroscopic Instruments (Leningrad, March 5-7, 1959). Deals with distortions of the spectra introduced by the recording systems of double-beam infrared spectrophotometers.

A.Tybulewic

535.3

10778 STROBOSCOPIC FLASH SOURCE FOR KINETIC SPECTROSCOPY.

J.H.Current, O.F.Raper, H.H.Kramer and E.J.Bair.

. Opt. Soc. Amer., Vol. 50, No. 7, 668-71 (July, 1960).

A stroboscopic light source is described for observing the inetic behaviour of chemical systems by absorption spectrometry. 'he light consists of a short train of flashes in an accurately timed equence. Such a system takes advantage of the brilliance of the enon flash source while at the same time making it possible to bserve the system at a sequence of times. Accurate timing is nherent in the apparatus.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

535.39

10779 AUTOMATIC COMPUTATION OF DIELECTRIC FILMS. M.Laikin.

. Opt. Soc. Amer., Vol. 50, No. 7, 721-2 (July, 1960).

A method is presented whereby the transmission and reflection rom multiple-layer dielectrics may be calculated. The equations re put into a form readily adapted to large computing machinery. seven-layer film combination is computed for various wavelengths.

535.41 : 534.21

MOIRÉ FRINGE ANALOGUE OF SOUND PROPAGATION IN HALLOW WATER. See Abstr. 10718

535.42

10780 FAR-FIELD DIFFRACTION PROPERTIES OF A PLANE-PARALLEL PLATE WHEN PLACED 'ARTIALLY IN FRONT OF A RECTANGULAR DIFFRACTING PERTURE. A.I.Mahan and L.P.Bone.

. Opt. Soc. Amer., Vol. 50, No. 7, 683-97 (July, 1960).

It has been possible, using Kirchhoff-type integrals, to develop ome optical equations for evaluating the form of the Fraunhofer iffraction patterns characteristic of a plane-parallel plate and ectangular diffracting aperture, when the plane-parallel plate has rbitrary positions and orientations in front of the rectangular iffracting aperture. The solution is an optical one, because the ectangular diffracting aperture is assumed to be large compared) the wavelength, diffraction effects in the plane of the rectangular iffracting aperture due to the edges of the plane-parallel plate are egligible, and multiple reflections between the edges of the rectan- ular diffracting aperture and plane-parallel plate have been neglec- ed. Within these initial assumptions it is rigorous, for the directly ansmitted and all the higher-order internally reflected wavefronts hich make contributions to the amplitude and phase in the plane of ne diffracting aperture have been considered. A Univac 1103A-type omputer has been used to calculate the forms of many of these iffraction patterns for particular choices of the nine possible ariables. Atempts were also made with a 21-ft Jarrell—Ash pectrograph to observe the corresponding experimental forms f these diffraction patterns. When an interferometer plate was ioved across, and in front of, the rectangular diffracting aperture, ie changes in form of the diffraction pattern were slow and could e followed in detail by corresponding theoretically calculated iffraction patterns. When, however, the interferometer plate was otated in front of the rectangular diffracting aperture about an axis assing through its centre, the changes became very rapid and equired a very large number of calculated diffraction patterns to llow all the detailed changes. The theory in general seems to be uite useful in predicting the possible forms of the corresponding xperimentally observed diffraction patterns.

535.42

10781 LIGHT DIFFRACTION BY TWO DISTORTED ULTRASONIC WAVES. W.G.Mayer and E.A.Hiedemann.

. Acoust. Soc. Amer., Vol. 32, No. 6, 706-8 (June, 1960).

Light intensities in the orders of diffraction patterns produced / two distorted ultrasonic waves 180° out of phase are investigated. the case where the two waves have the same intensity, the first ffraction orders vanish. The simultaneous increase in light tensity in the second orders is a measure of the second harmonic resent in the waves, given for varying distances from the trans- icers. The change in light intensities in the zero and second rders is given for varying pressure ratios of the two waves.

535.42

10782 DIFFRACTION OF LIGHT BY TWO ULTRASONIC WAVES OF THE SAME FREQUENCY. K.L.Zankel.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 709-13 (June, 1960).

The diffraction of light by two parallel ultrasonic waves of the same frequency is investigated. Measurements which were made with waves 180° out of phase with each other agreed with the predicted results. When the two waves were made nearly identical, the diffraction vanished almost completely. It is suggested that this might be applied as a method for the comparison of ultrasonic pressures, the measurement of absorption, and the investigation of finite amplitude distortion.

535.43

10783 ON THE DISTRIBUTION OF LIGHT IN A DIFFUSING MEDIUM ILLUMINATED BY A POINT SOURCE.

J.Lenoble.

C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3147-9 (May 9, 1960). In French.

On the assumption that the source radiates isotropically the luminance at a point is a function of τ, the distance from the source, and θ, the angle with the radius vector; it may therefore be represented by an expansion in Legendre polynomials in θ, the coefficients being functions of τ. The set of differential equations for these coefficients is found to be similar to one occurring in neutron transport theory and a solution is obtained by making use of this fact. W.T.Welford

535.43

10784 LIGHT SCATTERING OF MONODISPERSED POLYSTYRENE LATEXES. M.Kerker and E.Matijevic.

J. Opt. Soc. Amer., Vol. 50, No. 7, 722-9 (July, 1960).

The intensity of light scattered by four monodispersed polystyrene latexes has been measured at 45°, 90° and 135°. The polarization ratios and dissymmetries have been compared with newly computed Mie-theory functions. The range of validity of the Rayleigh—Gans theory for $m = 1.20$ has been discussed. A discrepancy between the experimental and theoretical values for the dissymmetry has been observed and accounted for in terms of secondary scattering.

535.43

10785 EVALUATION OF MIE EQUATIONS FOR COLORED SPHERES. F.C.Chromey.

J. Opt. Soc. Amer., Vol. 50, No. 7, 730-7 (July, 1960).

Tables are given to enable the computation of the scattering and absorption of light by coloured spheres. The parameters covered are $\alpha = 0.2$ (0.2) 2.0; $m = 0.50$ (0.25), 3.00; and $x = 0$ (0.1) 1.0.

535.43 : 532.7

10786 THE THEORY OF CRITICAL OPALESCENCE IN BINARY MIXTURES. F.J.Pearson.

Proc. Phys. Soc., Vol. 75, Pt 5, 633-9 (May, 1960).

The present theory of X-ray scattering by simple fluids and binary mixtures is applied to the phenomenon of critical opalescence in binary mixtures. Firstly, the condition for phase separation is expressed in terms of the three radial distribution functions for a binary mixture, and then it is shown that, at phase separation, these functions are all of the same form, although they differ in scale. The form of these functions can then, in principle, be determined from experimental observations of visible opalescence, although the normalization requires further discussion. The theory is then applied to the work of Fürth and Williams (1954), and of Quantie (1954), who suggested analytic representations of two types of radial distribution function. Only one of these is found to be acceptable.

535.51

10787 IMPROVEMENT OF SELENIUM FOIL POLARIZERS BY EXPLOITATION OF AN INTERFERENCE EFFECT.

J.H.Hertz.

Exper. Tech. der Phys., Vol. 7, No. 6, 277-80 (1959). In German.

By selection of the correct foil thickness the reflectivity of a sequence of foils used at Brewster angle as a polarizer can be much improved. With only three foils of the correct type a polarization of 99.5% is secured, by exploiting multiple reflection within the foil. S.Tolansky

535.56

10788 MAGNETIC ROTATORY POWER. EXPERIMENTAL DETERMINATION OF COVALENT ROTATIVITIES.

J.Grange and H.Fousse.

Cahiers de Phys., Vol. 13, 224-36 (June, 1959). In French.

The concept of covalence rotativity is explained. Rotativity for a diamagnetic substance at frequencies away from an absorption band is given by [Ω] where

$$[\Omega] = \frac{\Lambda}{d}\,\frac{9n}{(n^2+2)^2}\ \mu\text{rad. Oe}^{-1}\,\text{cm}^{-1}$$

in which Λ is the Verdet constant, d the density and n the refractive index of the substance. It takes into account the characteristic of the chemical bond. The effects of the different bonds are additive to the first order of approximation. Moreover there are reactions between neighbouring bonds which at times magnify considerably the rotativity. The results for a number of different types of bonding are deduced from a large series of magneto-optic measurements. H.G.Jerrard

COLORIMETRY . PHOTOGRAPHY

77

10789 ENERGY OF ACTIVATION OF THE THERMALLY-INDUCED FADING OF THE LATENT PHOTOGRAPHIC IMAGE. A.L.Kartuzhanskii and L.I.Shur.
Dokl. Akad. Nauk. SSSR, Vol. 131, No. 1, 64-7 (March 1, 1960). In Russian.

Presents a modification of and supplements, Meiklyar's method [Abstr. 4543 of 1953, and Zhurnal nauchnoi i prikladnoi fotografii i kinematografii, Vol. 4, 62 (1959)], and obtains formulae in a form enabling them to be used for the direct comparison of experimental data with theory. This method of evaluating the number of Ag atoms in the sub-centre and the energy of activation of any group of atoms not exceeding in size the sub-centre was used for interpreting the results of experiments with a fine-grained AgBr emulsion. The energy of activation was found to increase monotonously (but less than linearly) with the number of Ag atoms, while it was nearly constant for the cases when the Ag particle was the "pre-sub-centre" one, i.e. when only one atom was required to attain stability. F.Lachman

77 : 535.8

10790 MEASURING SPECTRAL TRANSMITTANCES OF PHOTOGRAPHIC OBJECTIVES WITH THE CARY MODEL 11 MS RECORDING SPECTROPHOTOMETER.
F.Grum and F.C.Williams.
J. Opt. Soc. Amer., Vol. 50, No.7, 675-7 (July, 1960).

Spectral densities of photographic lenses can be determined by the Cary Model 11 MS recording spectrophotometer if small apertures are placed in the sample and comparison compartments to reduce the diameter of the measuring beam, and a supplementary lens is used to concentrate the transmitted beam on the cathode of the phototube. The results are consistently reliable as long as the light transmitted through the sample lens can be made to fall on the phototube in approximately the same position as when the instrument was balanced.

77 : 539.19

10791 APPLICATION OF LEAST-SQUARES METHOD TO DENSITY—INTENSITY CALIBRATION IN ELECTRON DIFFRACTION STUDIES. K.Kimura and M.Kimura.
J. chem. Phys., Vol. 32, No. 5, 1398-401 (May, 1960).

A new method based on the principle of least squares is proposed for the calibration of the characteristics of photographic emulsion employed in electron diffraction studies. The calibration procedure consists of two steps. First, a function having three parameters was found which represents the relation between the optical density and exposure. Secondly, the most probable values of the parameters and their standard errors were determined in a straightforward way by the method of least squares. An application of this method to the diffraction patterns of benzene is described. The standard errors of final relative intensities were evaluated over the entire observed range of optical densities.

77 : 537.56

INVESTIGATION OF PULSED HIGH CURRENT GAS DISCHARGES BY HIGH SPEED PHOTOGRAPHY. See Abstr. 9041

HEAT . RADIATION

536.2 : 532.5 : 538.3 : 621.313.2

10792 THE THERMAL PROCESSES IN ELECTROMAGNETIC INDUCTION PUMPS. Ya.Lielpeter.
Latv.PSR Zinat. Akad. Vestis, No. 9 (146), 91-100 (1959). In Russia

The author is primarily concerned with the plane linear type of pump though the results can be used for cylindrical or spiral types if the gap thickness is substantially less than the radius of curvature of the duct. The three main heat circuits mentioned are: forced cooling with and without liquid-metal heat-loss compensation; and without forced cooling. The resistance to heat transmission from the liquid metal to the wall is shown to be negligible compared with the wall and insulating layer resistances. The stationary and non-stationary heat processes are dealt with. D.E.Brown

536.2

10793 THE CALCULATION OF HEAT TRANSFER IN A CASCADE OF BLADES. L.M.Zÿsina-Molozhen.
Zh. Tekh. Fiz., Vol. 29, No. 5, 625-31 (May, 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 5, 558-63 (Nov., 1959).

An approximate method of calculating the average heat transfer coefficient in a cascade of gas turbine blades is developed. A comparison is made with the experimental data of Wilson and Pope [Proceedings of the Institution of Mechanical Engineers, Vol. 168, 36 (1954)] and good agreement is obtained for all entering stream angles investigated at all values of the Reynold's number.
H.C.Cole

536.2

10794 EXPERIMENTAL STUDY OF THE EFFECT OF PRESSURE ON CONTACT THERMAL RESISTANCES.
H.Cordier and R.Maimi.
C. R. Acad. Sci. (Paris), Vol. 250, No. 17, 2853-5 (April 25, 1960). In French.

The arrangement consists of a central cylinder sandwiched between two side cylinders and surrounded by guard rings. The cylinders are of equal diameter, with the central cylinder electrically heated over its middle plane and the outside ends of the side cylinde watercooled. The temperature distribution along the axis is measur by means of 12 thermocouples inserted radially at intervals along th cylinders. The heat flux across the contacts was ~ $\frac{1}{2}$ Watt/cm^2, the mean temperature 20°C, and the pressures of contact used between 0 and 180 kg/cm^2. The results for the contact thermal resistance ar shown graphically as a function of pressure. In a compression cycl two values of resistance for a given pressure are obtained provided one proceeds from the minimum or maximum of the cycle.
S.Weintrou

536.

10795 FUSED QUARTZ AS THE STANDARD MATERIAL IN HEAT CONDUCTIVITY MEASUREMENTS.
E.D.Devyatkova, A.V.Petrov, I.A.Smirnov and B.Ya.Moizhes.
Fiz. tverdogo Tela, Vol. 2, No. 4, 738-46 (April, 1960). In Russian.

Heat conductivity of several quartz specimens was measured by 5 different methods. The fact that the same results were obtain irrespective of the method employed, and that the results were in good agreement with those quoted in American and British sources, indicated that quartz is eminently suitable for calibrating various calorimetric instruments and for measuring small quantities of hea
M.H.Slobod

536

10796 SIMPLE RADIANT HEATING METHOD FOR DETERMI ING THE THERMAL DIFFUSIVITY OF CELLULOSIC MATERIALS. S.B.Martin.
J. appl. Phys., Vol. 31, No. 6, 1101-4 (June, 1960).

A simple radiometric method for the determination of the thermal diffusivity of poorly conducting sheet-form materials such as cellulosic kindling fuels is described. The method is a dynami one based on the "long time" solution of the heat-conduction equati for the infinite slab with constant heat-input rate, and utilizes fine wire thermocouples laminated between sheets of the material (wh diffusivity is required) to measure rates of temperature rise at various depths. The geometry of the system is designed to satisfy as many as possible of the boundary conditions imposed on the mathematical model. The magnitude of errors introduced by viol the other boundary conditions is discussed in connection with the results of measurements on α-cellulose. The value of the thermal diffusivity of α-cellulose containing 2% carbon black and whose density is 0.68 g/cm^3 was found to be $1.06 \pm 0.06 \times 10^{-3}$ cm^2/sec.

536.2 : 533.7

10797 THERMAL CONDUCTIVITY OF HELIUM AND HYDROGEN AT HIGH TEMPERATURES.

N.C.Blais and J.B.Mann.
J. chem. Phys., Vol. 32, No. 5, 1459-65 (May, 1960).

A steady-state hot wire method for measuring the thermal conductivity of light gases in the temperature range 1200° to 2100°K is described. In contrast to other methods, free convection currents and large temperature gradients occur; convection effects are shown to be negligible, and the experimental procedure for eliminating the large gradient effects is described. The thermal conductivity of helium is found to follow the equation $\lambda \times 10^6 = 991 + 0.678$ $(T-1200)$ cal/sec cm deg over the temperature range covered. That for hydrogen is $\lambda \times 10^6 = 1434 + 1.257\,(T-1200)$ cal/sec cm deg.

536.2 : 537.533 : 621.385.13.032.22

THERMAL CALCULATIONS FOR ANODES OF ELECTRON TUBES COOLED BY RADIATION IN A VACUUM. See Abstr. 10944

536.3

10798 HEAT WAVE RADIATING ENERGY FROM ITS FRONT

É.I.Andriankin.
Zh. tekh. Fiz., Vol. 29, No. 11, 1368-72 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1258-62 (May, 1960).

Investigates the propagation of a non-progressive heat wave through a gas. The case is examined for which the path of the radiation in the cold gas is large for all frequencies below the critical frequency, and is small for high frequencies. The path of the quanta in the heated region is assumed to be much smaller than the radius of the wave front, since the radiant energy transfer takes place by means of heat conduction.

536.3

10799 A NOTE ON "USE OF AN ECONOMICAL THERMAL TRANSDUCER AS A NET RADIOMETER".

V.E.Suomi and P.M.Kuhn.
Bull. Amer. Meteorol. Soc., Vol. 41, No. 1, 32 (Jan., 1960).

Referring to the statement made by Fritschen and Van Wijk in a recent article with the above title (Abstr. 12891 of 1959) that the Suomi-Kuhn net radiometer yields too low a reading (~14% error), the present authors emphasize the necessity for developing a sound technique for instrumental comparison; they then proceed to discuss points on exposure and calibration that need to be carefully considered. It is concluded that a good network of simple and relatively inexpensive net radiometers of moderate accuracy is preferable to a limited number of more accurate and costly instruments. D.R.Barber

536.3

10800 UNCOOLED I.R.DETECTORS FOR LONG WAVE-LENGTHS. P.W.Kruse.

Electronics, Vol. 33, No. 13, 62-4 (March 25, 1960).

The indium antimonide photoelectromagnetic detector is described and discussed. The width of the forbidden band in this intrinsic semiconductor is only 0.18 eV at room temperature, thus the long wave limit of an uncooled InSb infrared detector is seven microns. A single crystal, in which both resistivity and electron mobility are high, is used. The magnetic field is produced by a permanent magnet. The detector described is about one inch in diameter and is 1.25 inches long. The signal to noise ratio in a 1 c/s bandwidth for radiant power, falling on the detector from a black body at 500°K, when chopped at 400 c/s is 10^8cm(c/s)$^{1/2}$W^{-1}. The signal voltage is about 0.7 V/W for 500°K radiation. The response time of the detector is not longer than 0.2 μs. As the detector does not require cooling it is less complex than comparable detectors. Several applications of the device are suggested. A.J.Salmon

536.3

10801 CRITERIA FOR THE PERFORMANCE OF INFRARED SYSTEMS. R.W.Powell.

J. Opt. Soc. Amer., Vol. 50, No. 7, 660-7 (July, 1960).

The performance of an infrared system is expressed by a number of characteristics. In military equipment where the most important factor is long detection ranges, the ability of the equipment to detect the target in the presence of noise determines performance. The selection of a criterion would be simple if an infrared detection system had to detect only one target through an atmosphere of known, constant composition. However, because each system is required to perform against a variety of target spectra and through atmospheres of varying composition, a more general method of performance evaluation is required. A new method, supplementing that currently used, is proposed. The responsivity curve of the equipment is obtained. The monochromatic (or nearly monochromatic) threshold of the system is determined at one or more points within the spectral passband where the responsivity is greater than 50%. The peak spectral threshold determined in this way expresses the least detectable flux to which the system can respond and is therefore believed to be a very important criterion. The relative response of the system to black-body radiation between 273°K (0°C) and 6000°K is computed from the response curve, thereby more completely defining the system performance against various targets and backgrounds.

536.3 : 539.12

RENORMALIZATION OF THE MASS OF AN ELECTRON IN A BLACK BODY. See Abstr. 9335

536.42

10802 HOW WATER FREEZES.

B.Chalmers.
Sci. American, Vol. 200, No. 2, 114-22, 122 (Feb., 1959).

A non-specialist article. The formation of ice crystals requires not only low temperatures but nuclei of appropriate size and shape. Such nuclei explain the strange diversity of snowflakes, "ice worms", and frost leaves.

536.42

10803 THE FREEZING POINTS OF HIGH PURITY METALS AS PRECISION TEMPERATURE STANDARDS.

VI. THERMAL ANALYSES ON FIVE SAMPLES OF LEAD WITH PURITIES GREATER THAN 99.999+%.

E.H.McLaren and E.G.Murdock.
Canad. J. Phys., Vol. 38, No. 5, 577-87 (May, 1960).

For Pt V see Abstr. 2271 of 1960. An investigation has been made of the freezing and melting temperatures of five samples of high purity lead (supplier's analysed impurity contents < 0.7 to < 4 p.p.m.) including zone refined metal. Using the induced freezing technique, plateaux of essentially constant ($< \pm 0.0001$° C) temperature with durations of over 1 hr are readily obtained on the cooling curves of these samples. A standard deviation in plateau temperature (liquidus point) of ±0.0001° C was obtained from a series of 30 induced freezes on a particular sample. The pressure effect on the freezing temperature of lead was found to be 0.0080° C for 1 atm. A value of 327.426° C (Int. 1948) was determined for the standard liquidus point of pure lead. The liquidus points of the samples were intercompared with a precision of about 0.0002° C, and alloy melting ranges were examined following different types of freezing with and without overnight anneals near the solidus temperature. Alloy melting range parameters were found to be useful in the selection of the samples of highest purity and at the same time showed that an uncertainty of 0.002° C in the above value of the liquidus point of pure lead may exist because of residual impurity contents in the purest samples that were examined.

536.42

10804 ON THE MELTING AND FREEZING BEHAVIORS OF LIQUID HELD IN THE VERY NARROW CAPILLARY.

T.Takamura.
Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 1, 16-21 (June, 1958).

From the standpoint of phase nucleation theory, melting and freezing temperatures have been given theoretically for liquid held in a microcapillary. It has been deduced that the freezing temperature of the liquid in the microcapillary is always lower than the melting temperature in the same situation.

536.42

10805 INVESTIGATION OF THE DISTRIBUTION OF VAPOUR CONTENT IN THE BOILING BOUNDARY LAYER BY BETA-TRANSLUCENCE. M.A.Styrikovich and E.I.Nevstrueva.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 5, 1019-22 (Feb. 11, 1960). In Russian.

Water, circulating in a closed circuit and preheated to a suitable temperature, was brought to boil in a special cell (width 4 mm, height ~20 mm) with a built-in β source (window width 10 mm, height 0.3 mm), the heating element being provided in the adjustable bottom of the cell, so that a 10×0.3 mm layer of the boiling liquid could be examined with β rays at a distance 0-6 mm from the bottom. The vapour content was found to change little with temperature at higher temperatures, when the examination was carried out at a distance from the bottom (heat source) smaller than the thickness of the layer in which bubbles form and increase; the effect of the velocity of circulating water was particularly great in the zone where the separated vapour bubbles condense. The final conclusion is that, when the temperature of the stream and the heat load approach critical values, the thickness of the boiling layer is relatively small, while local vapour contents attain sometimes 0.98. The higher the critical heat load the thicker the boiling layer and the smaller the local vapour contents. F.Lachman

536.42 : 539.17

10806 THE DENSITY OF STEAM—WATER MIXTURES FORMED DURING RAPID REDUCTIONS IN PRESSURE.

V.K.Zavoiskii, V.N.Vorobiev and R.K.Serdiuk.

J. nuclear Energy, Vol. 9, No. 1-4, 183-5 (June, 1959). English translation of article in: Atomnaya Energiya, Vol. 4, 285 (1958).

The temperature and density of steam—water mixtures in a steel cylinder of 20 cm internal diameter and 1.5 m height containing heated water were measured in order to assess the extent to which bulk boiling could occur in a pressurized water reactor. The apparatus is described and illustrated. The density was determined from the degree of absorption of a beam of gamma-rays from a radioactive Ag source. The pressure drop was from 50 to 5 atm. A graph of the experimental results showing the relation between the proportion of the cross-section of the cylinder occupied by steam and the velocity of the steam, for pressures of 20 and 40 atm, is given. S.Weintroub

536.42

10807 INVESTIGATION OF THE MECHANISM OF BOILING A MIXTURE OF ALUMINUM BROMIDE AND CHLORIDE, AND A MIXTURE OF ANTIMONY BROMIDE AND CHLORIDE.

V.A.Robin.

Zh. tekh. Fiz., Vol. 29, No. 9, 1152-5 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 1051-4 (March, 1960).

Boiling halide mixtures wet a glass surface, yet their boiling mechanism differs not only from that of non-wetting liquids, but also from that of water. The reasons for this are the lower surface tension of the halide mixtures, and also the continuous change in composition of vapour and liquid during boiling. In a vertical tube the vapour bubbles rise through the boiling halide mixture, rather than sliding along the glass wall, so that the wall is well washed by the transferring liquid. R.Schnurmann

536.46

10808 EFFECT OF SOLID PROPELLANT COMPRESSIBILITY ON COMBUSTION INSTABILITY.

J.F.Bird, L.Haar, R.W.Hart and F.T.McClure.

J. chem. Phys., Vol. 32, No. 5, 1423-9 (May, 1960).

The theory of the interaction of sound with a burning propellant surface (Abstr. 6844 of 1959) is extended to include density fluctuations of the solid propellant. Both compressibility and thermal expansion are treated, but the latter is found to be less important than the former. For reasonable values of the compressibility, it is shown that the acoustic response, Real (μ/ϵ), of the surface is reduced by as much as 0.1 in a broad range of frequency around several kc/s. A simple low-frequency approximation for the burning surface response is also discussed.

536.46 : 534.22

10809 PRE-DETONATION MECHANISM OF FLAME PROPAGATION IN ROUGHENED TUBES.

V.S.Babkin and L.S.Kozachenko.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 3, 591-2 (March 21, 1960). In Russian.

Combustion experiments were made with mixtures of hydrogen, oxygen and nitrogen, contained in a tube of square shaped cross-section. Two walls were roughened by the attachment of brass shavings; the other two walls were made of optical glass and used for photographic observation. Combustion was started near the closed end of the tube. Flow in the combustion zone was at first laminar; later it became turbulent, giving the combustion front a slightly convex curvature. Eventually a shock front emerged which propagated along the roughened walls and hence towards the centre of the tube. The speed of propagation of the shock front was measured and found to vary between 890 and 1380 m/sec, according to the composition of the mixture. R.Eisenschitz

536.46 : 536.52

10810 LAWS OF THE TEMPERATURE EMISSION OF THE FLAME. B.I.Plyukhin.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 1, 68-71 (March 1, 1960). In Russian.

After an analysis of the laws and assumptions used in flame temperature measurements the author derives a transcendental equation for hydrogen-type gases, whose solutions are given in a table. The two extreme cases (the optically dense and not dense flame) are expressed analytically. The non-hydrogen-type gases are similarly treated: for the optically dense flame the Stefan—Boltzmann law is obeyed. F.Lachman

536.5 : 534.22

MEASUREMENT OF THE GAS TEMPERATURE BEHIND A SHOCK WAVE. See Abstr. 10727

536.5

10811 THE SOURCE OF NOISE IN EBULLIOMETRY. W.R.Blackmore.

Canad. J. Phys., Vol. 38, No. 4, 565-7 (April, 1960).

Describes measurements to check whether the noise observed in ebulliometers arises in the ebulliometers themselves or in the temperature-sensing devices (thermistors). The results show that the noise arises in the ebulliometer. R.C.Glass

536.52 : 535.

10812 ABSORBING FILTERS AND HIGH-TEMPERATURE OPTICAL PYROMETRY. D.R.Lovejoy.

J. Opt. Soc. Amer., Vol. 50, No. 7, 698-706 (July, 1960).

It is shown by calculations based on spectral transmission data that Chance ON30 neutral and Corning Pyrometer Brown glasses m be used as constant-absorption absorbing filters in optical pyromet to measure indefinitely high-luminance temperatures with calculable accuracy. In the case of Chance ON30 glass below 2500°K, the constant absorption was confirmed by direct calibration using a rotatin sectored disk. Corrections have been calculated to 8000°K, to change from temperatures based on Wien's law to temperatures based on Planck's law. A number of minor precautions necessary to achieve the greatest possible accuracy have been noted and standard-deviation accuracies have been calculated for high temper tures. The theory of optical pyrometry has been developed, in an appendix, in a form suitable for discussion of high-temperature measurements.

536.5

10813 THE PERFECTING OF A SIMPLE DIFFERENTIAL MICROCALORIMETER OF SHORT TIME CONSTANT.

D.Blet-Talbot.

J. Phys. Radium, Vol. 19, Suppl. No. 7, 102A-108A (July, 1958). In French.

In order to study the thermodynamics of a selenium photocell, a simple microcalorimeter with a short time constant of about 15 has been designed. Its characteristics are discussed and the optic arrangement described. With this calorimeter is associated a feedback galvanometer amplifier, since theory permits only one thermocouple to be used. Performance of such an amplifier is studied and calibration of both calorimeter and amplifier is given. A sensitivity of 0.1 microwatt is obtained.

536.55 : 541.

10814 TEMPERATURE MEASUREMENT OF THE FRONT OF DETONATION OF EXPLOSIVES.

I.M.Voskoboinikov and A.Ya.Apin.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 4, 804-6 (Feb. 1, 1960). In Russian.

By recording the luminescence of the front of a detonation in a charge of transparent liquid or semi-transparent solid explosives, by the electron-optical method (photomultiplier and oscillograph), it was found that the respective spectra in the range 400-600 mμ were similar to those of grey or black bodies with temperatures between about 3000° and 5000° K. The temperatures and velocities of detonation were determined and are tabulated for 8 explosives. The results are discussed. F.Lachm

THERMODYNAMICS

536.7

10815 THERMODYNAMICAL RELATIONS IN TWO-COMPONENT TWO-PHASE SYSTEMS. H.Kaufman.
Nature (London), Vol. 186, 299 (April 23, 1960).

Jacobians are used to obtain in a simple manner some thermodynamic properties of two-component two-phase systems.
P.T.Landsberg

LOW-TEMPERATURE PHYSICS

536.48

10816 PROPERTIES OF THE SPECTRUM OF ELEMENTARY EXCITATIONS NEAR THE DISINTEGRATION THRESHOLD OF THE EXCITATIONS. L.P.Pitaevskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1168-78 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 830-7 (Oct., 1959).

The singularity of the Bose-liquid Green's function near the excitation disintegration threshold is investigated by quantum-field theory methods without assuming weakness of the interaction. It is shown that three possible types of decay threshold exist. In the first case, the excitation velocity at the threshold point $p = p_c$ equals that of sound, so that starting with this point the excitation can produce phonons, thus leading to damping proportional to $(p_c - p)^3$. In the two other cases, excitation at the threshold can break up into two excitations with non zero momenta, which are either parallel to each other or form a definite angle. In either case, the spectrum curve ends at the threshold point, and the excitation velocity at this point equals that of each of the excitations produced in the decay. Scattering of neutrons in the liquid, involving the production of excitations near the threshold is considered.

536.48

10817 A HYPOTHESIS ON THE SUPERFLUID STATE. J.Winter.
. Phys., Radium, Vol. 19, No. 5, 532-5 (May, 1958). In French.

The author presents a development of an idea of London's, (that superfluid helium is a Bose—Einstein gas), by a supplementary assumption : the adoption of the wave point of view, which means the delocalization of superfluid helium atoms. Some consequences of this assumption are discussed.

536.48

10818 THE LANDAU CORRECTION COEFFICIENT IN THE DETERMINATION OF THE VISCOSITY OF A LIQUID.
G.A.Gamtsemlidze.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 855-7 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 609-10 (March, 1960).

The viscosity of the normal component of liquid helium II was measured as a function of temperature by observing damped angular oscillations, in the liquid, of the bob of a torsional pendulum, comprising a number of coaxial disks of the same radius rigidly attached together. The effect of disk thickness was studied and eliminated by repeating the experiment with different numbers of disks of the same aggregate thickness. Viscosities previously obtained by using Landau's empirical correction factor for disk thickness (in the formula for viscosity from oscillating-disk experiments) agree to within 5 or 7% of the latest values.
J.G.Oldroyd

536.48

10819 THE EFFECT OF A HEAT CURRENT OR ROTATION ON SOUND PROPAGATION IN LIQUID HELIUM.
.E.Chase, J.Fineman and W.E.Millett.
Physica, Vol. 25, No. 7, 631-2 (July, 1959).

A steady heat current had no measurable effect on the velocity or attenuation of 1 Mc/s ultrasonic waves in helium; nor had rotation of the apparatus. These null results would be expected, since the phonon mean free path is small compared with the vortex line separation.
R.G.Chambers

536.48

10820 P.V.T. ANOMALIES IN He^3 NEAR ITS MELTING CURVE. S.G.Sydoriak, R.L.Mills and E.R.Grilly.
Phys. Rev. Letters, Vol. 4, No. 10, 495-7 (May 15, 1960).

The difference in volume between the liquid and the solid phase of He^3 is measured below 1°K down to 0.3°. Also the coefficient of thermal expansion and the compressibility of the liquid phase are measured in the same range of temperatures and at densities near the melting curve. Results are found to fit well, or in some instances, fairly well to the known data at higher temperatures. The thermal expansion coefficient of the liquid was known to be negative at temperatures below 1.2°. This negative sign is found to persist at lower temperatures. Also it is found by calculation that the thermal expansion of the solid phase is negative approximately at the same temperatures. Results are in agreement with the existence of a minimum of the melting curve at $\cong 0.32^\circ$. It is found that near this temperature the entropy change at melting changes its sign.
R.Eisenschitz

536.48

10821 PRESSURE—VOLUME—TEMPERATURE RELATIONS OF LIQUID He^3 FROM 1.00 TO 3.30°K.
R.H.Sherman and F.J.Edeskuty.
Ann. Phys. (New York), Vol. 9, No. 4, 522-47 (April, 1960).

Accurate P—V—T measurements were made for liquid He^3 from 0.98 to 3.32°K and from saturation pressure to the melting pressure. Included are measurements of the locus of the zero of the coefficient of expansion on the P—V—T surface and of the melting curve. Coefficients of expansion and compressibility were deduced from the volume data and from these entropies of compression and heat capacities were computed. Tables of all these quantities are included as well as properties of the saturated liquid.

536.48 : 539.11

LEVEL STRUCTURE OF LIQUID He^3. See Abstr. 11124

536.48

10822 VAPOR PRESSURES OF He^3—He^4 MIXTURES. S.G.Sydoriak and T.R.Roberts.
Phys. Rev., Vol. 118, No. 4, 901-12 (May 15, 1960).

Vapour pressures, P_X, of He^3—He^4 mixtures ranging in liquid mole fraction, X, from 0.1 to 0.9 were measured between 0.6° and 2.4°K versus the vapour pressure, P_3^0, of liquid He^3. Except for sharp breaks in the vicinity of the lambda and stratification temperatures of some of the mixtures, P_X/P_3^0 is found to vary slowly and smoothly with X and with temperature. Contrary to much of the work of other authors, there are no breaks at the He^4 lambda temperature. A comprehensive smoothed table of P_X/P_3^0 is derived. Using this as a reference it is possible, for the first time, to intercompare all of the previously existing data on P_X. The data of some authors are in excellent agreement with this table but other data are in serious quantitative disagreement near 1.2°K and much previous data are in qualitative disagreement at the He^4 lambda temperature.

536.48

10823 MIXTURES OF ^{3}He AND ^{4}He. K.W.Taconis.
Physica, Vol. 24, Supplement, S9-S12 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A brief review of experimental work on various thermodynamic and flow properties. No references.
R.G.Chambers

536.48

10824 CRITICAL VELOCITIES FOR FLOW OF He II IN CAPILLARIES. B.T.Geilikman.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 891-2 (Sept., 1959). In Russian. English translation in Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 635-6 (March, 1960).

Equations are derived for the critical velocity in channels of circular and rectangular cross-section, on the basis of the Onsager—Feynman theory.
R.G.Chambers

536.48

10825 THE CRITICAL REGION IN EXPERIMENTS WITH AN OSCILLATING DISK IN HELIUM II. G.A.Gamtsemlidze.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 950-6 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 678-81 (April, 1960).

The results of measurement of damping of the oscillations of a disk immersed in helium II are presented. Onset of the critical state and motion of the disk at supercritical velocities were investigated. Dependence of the critical velocity on temperature and oscillation period was studied. The critical velocity was found to depend on the cleanliness of the disk surface. Dependence of the critical velocity on the number and size of small particles deposited on the disk surface and also on the radius of the region covered by the particles was studied. Dependence of the damping decrement in the supercritical region on temperature, particle concentration and radius of the particle-covered region was also studied.

536.48

10826 HYDRODYNAMICS OF SOLUTIONS OF STRANGE PARTICLES IN HELIUM II NEAR THE λ POINT.

D.G.Sanikidze.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 320-1 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 226-7 (Jan., 1960).

Quotes the results of a calculation in which previous treatments are generalized by regarding the superfluid density ρ_s as a quantity to be determined, rather than as a given parameter.
R.G.Chambers

536.48

10827 EXPERIMENTAL INVESTIGATION OF THE HARMONIC OSCILLATIONS OF A DISK IN ROTATING HELIUM II.

É.L.Andronikashvili and D.S.Tsakadze.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 562-4 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 397-8 (Feb., 1960).

Previous studies of the period of oscillation have now been extended to a study of the damping, which is found to be considerably larger for a rough disk than for a smooth one, and to pass through a peak (for both disks) when the angular velocity of the bath is about 0.06 $\sec^{-1}$. The height of the peak rises with falling temperature.
R.G.Chambers

536.48

10828 THE PROPAGATION OF OSCILLATIONS ALONG VORTEX LINES IN ROTATING HELIUM II.

É.L.Andronikashvili and D.S.Tsakadze.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 322-3 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 227-8 (Jan., 1960).

The decrement of a disk oscillating in rotating helium II is found to vary periodically with the height of the helium surface above the disk.
R.G.Chambers

536.48

10829 THE USE OF A SUPERCONDUCTING RING FOR REGISTERING THE PHASE TRANSITION IN LIQUID HELIUM.

B.N.Esel'son and A.D.Shvets.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 323-4 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1. 228-9 (Jan., 1960).

The e.m.f. in a pickup coil is used to detect the changing flux through a superconducting ring, carrying its critical current, as the temperature slowly rises. A sharp break occurs at the λ-point.
R.G.Chambers

536.48

10830 ON THE SUPERFLUIDITY OF A SYSTEM OF POLAR BOSE EXCITATIONS.

S.V.Vonsovskii and M.S.Svirskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1259-66 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 894-8 (Oct., 1959).

Considers the possibility of superconductivity in a metal for which the elementary current-carrying excitations can be treated as quasi-bosons. Using Bogolyubov's method, it is concluded that such a metal may become superconducting at low temperatures if the number of electrons per atom is small and the exchange integral negative; the behaviour will not depend appreciably on the isotopic mass.
R.G.Chambers

536.48

10831 MIRAGES OF SUPERCONDUCTIVITY.

L.Brillouin.
J. Phys. Radium., Vol. 19, No. 1, 112 (Jan., 1958). In French.

A brief but violent attack on the B.C.S. theory (Abstr. 6193 of 1957), on the ground that it cannot explain persistent currents.
R.G.Chambers

536.48

10832 A COMMENT ON BARDEEN'S THEORY OF SUPERCONDUCTIVITY.

S.Nakajima and T.Kasuya.
Progr. theor. Phys., Vol. 18, No. 6, 662-3 (Dec., 1957).

This criticism of the Bardeen, Cooper and Schrieffer theory was withdrawn in an erratum[Progr. theor. Phys., Vol. 20, No. 5, 783 (Nov. 1958)].
D.J.Thouless

536.48

10833 THEORY OF SUPERCONDUCTIVITY.

J.Bardeen.
Physica, Vol. 24, Supplement, S27-S34 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960) A review of: basic B.C.S. theory and the Bogolyubov—Valatin formulation; matrix elements for scattering with and without spin-flip, and the relevant experiments; the Meissner effect and penetration depth; thermal conductivity. 24 references.
R.G.Chambers

536.48

10834 EXPERIMENTAL CRITERIA FOR THE THEORY OF SUPERCONDUCTIVITY.

A.B.Pippard.
Physica, Vol. 24, Supplement, S48-S52 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960) The experimental background of superconductivity is discussed with reference to the B.C.S. theory. Discrepancies are noted, in particular with regard to the variation of penetration depth with temperature; there is also some speculation about scattering processes.
L.Mackinnon

536.48

10835 A SIMPLE MODEL IN THE THEORY OF SUPERCONDUCTIVITY.

Yu.B.Rumer.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 578-80 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 37(10), No. 2, 409-10 (Feb., 1960).

A model of interacting fermions in the superconducting state is constructed by treating a pair of fermions as a boson. The problem can then be attacked by using the methods of the theory of the superfluidity of interacting bosons. This leads to results in agreement with the usual theory of superconductivity.
D.J.Thouless

536.4

10836 MICROSCOPIC DERIVATION OF THE GINZBURG—LANDAU EQUATIONS IN THE THEORY OF SUPERCONDUCTIVITY.

L.P.Gor'kov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1918-23 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 36(9), No. 6, 1364-7 (Dec., 1959).

It is shown that the phenomenological Ginzburg—Landau equati follow from the theory of superconductivity in the London temperature region in the neighbourhood of T_c. In these equations, there occurs, however, twice the electronic charge; this is related to the physical meaning of $\Psi(x)$ as the wave function for Cooper pairs. The constant κ turns out to be small. The problem of the surface energy for the boundary between the normal and superconducting phases in the neighbourhood of T_c is discussed.

536.4

10837 THE BASIC COMPENSATION EQUATION IN SUPERCONDUCTIVITY THEORY WHEN THE COULOMB INTERACTION IS TAKEN INTO ACCOUNT.

Chén' Chun'-Syan' and Chzhou Si-Shin'.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1246-53 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York Vol. 36(9), No. 4, 885-9 (Oct., 1959).

Fröhlich's model is studied by the Bogolyubov method taking the Coulomb interaction into account. A partial summation of the perturbation theory series is performed by approximate second quantization in order to eliminate the infrared divergence. The basic compensation equation for dangerous diagrams and an expression for the renormalized single fermion excitation energy for the case when the Coulomb interaction is taken into account ar obtained in explicit form as a result and are discussed.

536.4

10838 GROUND-STATE ENERGY AND GREEN'S FUNCTION FOR REDUCED HAMILTONIAN FOR SUPERCONDUCTIVITY.

J.Bardeen and G.Rickayzen.
Phys. Rev., Vol. 118, No. 4, 936-7 (May 15, 1960).

In their theory of superconductivity, Bardeen, Cooper and Schrieffer (Abstr. 1708 of 1958) made use of a reduced Hamiltonia hich included only scattering of pairs of particles of opposite omentum and spin. It is shown that the solution they obtained by variational method is correct to O(1/n) for a large system. The ngle particle Green's function is derived and used to calculate the teraction energy.

536.48

10839 SUPERFLUIDITY AND SUPERCONDUCTIVITY IN ELECTRON GASES. G.Wentzel.

hys. Rev. Letters, Vol. 4, No. 7, 349-51 (April 1, 1960).

Discusses various models of the electron gas and their corres- onding "moments of inertia". H.N.V.Temperley

536.48

10840 THE INTERMEDIATE STATE IN SUPERCONDUCTING PLATES. T.E.Faber.

roc. Roy. Soc.A, Vol. 248, 460-81 (Dec. 9, 1958).

A powder technique has been used to study the equilibrium struc- ure of the intermediate state, in flat plates of aluminium subjected a perpendicular magnetic field. The characteristic domain spacing as been measured as a function of field strength and temperature r three plates of different thickness, and the results are interpreted terms of a new theory, based on the original theory of Landau but odified to take account of the complicated way in which the indivi- ual normal domains are corrugated. Values are deduced for the urface tension parameter Δ which are in reasonable agreement with ose obtained previously by a different method. Measurements have so been made using a slanting field as suggested by Sharvin (Abstr. 93 of 1958), since it has the effect of aligning the domains in the termediate state and suppressing their corrugations, so that the eory ought to be simpler for this case. The kinetic effects that ccur when equilibrium is disturbed by altering the strength of the eld have also been observed, in tin plates as well as aluminium nes. Tin has the advantage for this purpose of a larger critical eld, large enough to shift the powder as the lines of force migrate rough the specimen. Theoretical explanations are suggested for a umber of the effects; in particular, a formula is obtained for the te of penetration of flux towards the centre of the specimen when e field is first switched on, which agrees adequately with the obser- ations. Patterns have been obtained with aluminium showing how ux is trapped when the applied field is reduced to zero. They de- onstrate convincingly that two superconducting regions are unable coalesce across an intervening layer of the normal phase.

536.48

10841 SURFACE IMPEDANCE OF SUPERCONDUCTORS. P.B.Miller.

hys. Rev., Vol. 118, No. 4, 928-34 (May 15, 1960).

A detailed calculation of the surface impedance of super- onductors is given based on the general theory of the anomalous kin effect in normal and superconducting metals given by Mattis nd Bardeen (Abstr. 1482 of 1959). It is found that there are large orrections to the extreme anomalous limit value of the super- onducting to normal surface resistance ratio; corrections to the urface reactance ratio are much smaller. The theory is com- ared with recent experiments on the surface impedance of luminium and of tin. It is found that the theory gives satisfactory greement with experimental data on the surface impedance, both absolute value and in its temperature and frequency dependence ver a wide range of temperatures and frequencies.

536.48

10842 TRANSVERSE COLLECTIVE EXCITATIONS IN SUPERCONDUCTORS AND ELECTROMAGNETIC BSORPTION. T.Tsuneto.

hys. Rev., Vol. 118, No. 4, 1029-35 (May 15, 1960).

With use of the generalized random phase approximation and ttempt is made to estimate the absorption of photons with energy ess than the energy gap due to transverse collective excitations. he ratio of the surface resistance due to transverse collective xcitations to that of normal metals in the extreme anomalous limit, alculated within the weak coupling theory, turns out to be too small explain the observed data for superconducting lead and mercury. Abstr. 1083 of 1960). The interpretation of the collective excita- ons as bound pair states is briefly discussed.

536.48

10843 THERMAL CONDUCTIVITY OF SUPERCONDUCTORS. K.Mendelssohn.

hysica, Vol. 24, Supplement, S53-S62 (Sept., 1958).

Low Temperature Physics Conference (See Abstr. 7017 of 1960). Describes measurements made on a lead single crystal, a lead alloy with 1% bismuth, single crystals of niobium and tantalum and vanadium specimens, under various degrees of strain. The thermal conductivity in both the superconducting and normal states was measured. The apparatus used for lead is briefly described. The results are shown graphically and confirm the value of thermal conduction measurements for the investigation of metal imperfections. The density of dislocation lines may be determined from the large phonon conduction in the superconducting state, and the computed values compare favourably with theoretical values calculated from van Bueren's formula [Acta Metallurgica, Vol. 3, 522 (1955)]. S.Weintroub

536.48

10844 THE INFLUENCE OF ANISOTROPY ON THE THERMAL CONDUCTIVITY OF SUPERCONDUCTORS.

I.M.Khalatnikov.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1818-22 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1296-9 (Dec., 1959).

The electronic part of the thermal conductivity is evaluated, taking anisotropy into account. It is shown that the temperature dependence of the thermal conductivity may be different along different crystallographic axes for uniaxial crystals.

536.48 : 539.2 : 535

10845 ABSORPTION OF ELECTROMAGNETIC RADIATION IN SUPERCONDUCTORS. M.Tinkham.

Physica, Vol. 24, Supplement, S35-S41 (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Experiments on the absorption of far infrared radiation in super-conductors are discussed, and the results are interpreted in terms of the energy-gap. L.Mackinnon

536.48

10846 SUPERCONDUCTIVITY OF BERYLLIUM AND ITS LOW TEMPERATURE POLYMORPHISM.

B.G.Lazarev, A.I.Sudovtsov and E.E.Semenenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1461-3 (Nov., 1959). In Russian.

The temperature dependence of the electrical resistivity R of 400-2500 A thick Be films, vacuum deposited at the liquid He temperature, was determined in the 3-360°K range. All specimens became superconducting at 7-9°K, but irreversible loss of super-conductivity occurred on heating to temperatures > 60°K from which the existence of a superconducting modification of Be, stable below 30°K, was inferred. A decrease in R, observed at ~ 200°K, was attributed either to the existence of another modification of Be or to its recrystallization. M.H.Sloboda

536.48

10847 SUPERCONDUCTIVITY OF THE COMPOUND BiPt. N.N.Zhuravlev, A.A.Stepanova and N.I.Zyuzin.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 880-1 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 627-8 (March, 1960)

X-ray studies show that if BiPt is cooled too rapidly from the liquid phase, defects appear in the structure, which shows a fall in unit cell size and a rise in Bi content. This may account for the wide range of transition temperatures (1.2-2.4° K) observed by different workers. R.G.Chambers

536.48

10848 STUDY OF THE INTERMEDIATE STATE IN SUPER-CONDUCTORS USING CERIUM PHOSPHATE GLASS.

W.DeSorbo.

Phys. Rev. Letters, Vol. 4, No. 8, 406-8 (April 15, 1960).

Preliminary report on domain patterns detected by Faraday rotation in a glass plate 0.25 mm thick, close to the surface of the specimen. The method allows slowly changing patterns to be followed, and enables both the magnitude and sign of the local field to be deter-mined. Patterns on cold-worked Ta and non-equilibrium patterns on zone-refined Sn are shown and discussed. R.G.Chambers

536 48

10849 SUPERCONDUCTIVITY OF ELECTRODEPOSITED COPPER—BISMUTH ALLOYS.

N.E.Alekseevskii, V.V.Bondar' and Yu.M.Polykarov.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 294-5 (Jan., 1960). In Russian.

0.05 mm thick layers of Cu—Bi alloys (25-90 wt.% Bi), electro-deposited from a 1N $Cu(ClO_4)_2$, 4N $Bi(ClO_4)_3$, and 4N $HClO_4$ solution at the current density of 80-250 mA/cm^2, became superconductive at about 2.3°K. Since this effect was not observed in specimens annealed at 120°C, it was postulated that superconductivity of electrodeposited Cu—Bi alloys is due to the presence of a metastable phase of unknown nature, which is formed when electrodeposition takes place under conditions of high overvoltage, and which decomposes at temperatures $\geq 120^\circ$C. M.H.Sloboda

536.48

10850 HIGH-FREQUENCY STUDIES ON SUPERCONDUCTING TIN.

M.S.Dresselhaus and G.Dresselhaus.

Phys. Rev. Letters, Vol. 4, No. 8, 401-3 (April 15, 1960).

Measurements of the surface impedance of superconducting tin both with and without a magnetic field are analysed. It is found that the zero-field measurements are less sensitive to the band structure than the measurements with a magnetic field. It appears that electrons with a high effective mass tend to dominate in the presence of a field. D.J.Thouless

536.48

10851 THEORY OF SUPERCONDUCTING CONTACTS.

R.H.Parmenter.

Phys. Rev., Vol. 118, No. 5, 1173-82 (June 1, 1960).

The BCS theory of superconductivity (Abstr. 1708 of 1958) is generalized to the case of a position-dependent energy gap (at the absolute zero of temperature and in the absence of magnetic fields) The BCS integral equation for the energy gap goes over into an integro-differential equation. The latter has nontrivial solutions (i.e. finite energy gap) even for the case of normal material (V = 0). Expressions are obtained for the energy gap, for the volume energy density, and for the surface energy density at an interface, for both normal and superconducting material. These results are applied to a number of problems involving superconducting contacts. When a thin slice of normal material is sandwiched between bulk superconductors, it is found that the slice acts superconducting for thicknesses less than about 10^{-5} cm. When a thin slice of superconductor is sandwiched between bulk normal material, the slice acts like normal material for thicknesses less than about 10^{-5} cm. The energy gap at the free surface of a bulk superconductor may differ by as much as 30% from its constant value deep inside the material, the former being either larger or smaller than the latter, depending on the value of N(0) V, where N(0) is the density of one-electron states of a given spin at the Fermi level in the normal metal.

536.48

10852 FAR INFRARED TRANSMISSION THROUGH SUPERCONDUCTING FILMS.

D.M.Ginsberg and M.Tinkham.

Phys. Rev., Vol. 118, No. 4, 990-1000 (May 15, 1960).

The far infrared transmission through films of superconducting and normal lead, tin, indium, and mercury was measured in the wavelength region between 0.1 and 1.1 mm. The transmission data were analysed to find the ratio of the complex conductivity in the superconducting state to that in the normal state, as a function of frequency. The width of the energy gap at 0°K may be estimated from the frequency of the extrapolated cutoff of the real part, $\sigma_1(\omega)$, of the superconducting conductivity. The values so obtained are 4.0 ± 0.5, 3.3 ± 0.2, and 3.9 ± 0.3 kT_C for lead, tin, and indium, respectively. These values are in good agreement with those obtained in other experiments on bulk samples. The frequency dependence of $\sigma_1(\omega)/\sigma_N$ is in qualitative agreement with the results of a calculation by Mattis and Bardeen based on the theory of Bardeen, Cooper, and Schrieffer, except for an unexpected hump in $\sigma_1(\omega)$ for lead and (tentatively) mercury at low frequencies. This hump may be due to the production of collective excitations or an anisotropy in the energy gap. It has also been found that a magnetic field as high as 8000 G applied in the plane of a lead film about 12 A thick has only a very small effect on the electromagnetic properties of the film. This is not surprising, in view of the results of the microwave experiments of Pippard and of Spiewak.

536.48

10853 MEASUREMENT OF MAGNETIC-FIELD ATTENUATION BY THIN SUPERCONDUCTING FILMS.

E.Erlbach, R.L.Garwin and M.P.Sarachik.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 107-15 (April, 1960).

The dependence of the field attenuation on temperature and superimposed d.c. magnetic field is measured with a sensitive r.f. bridge. It is shown theoretically that the penetration depth λ can be derived from the attenuation measurements, and the experiment therefore yields λ as a function of temperature and d.c. magnetic field. Changes in λ can be detected to an accuracy of ±0.03%. Preliminary data on the temperature dependence of λ for lead are compared with the predictions of the Bardeen—Cooper—Schrieffer theory and are shown to be consistent with an energy gap between 4.9 kT_C and 5.4 kT_C at 0°K. Detailed descriptions are given of the apparatus and of the preparation of the samples.

536.48

10854 SUPERCONDUCTING TIN FILMS OF LOW RESIDUAL RESISTIVITY.

G.J.Kahan, R.B.DeLano, Jr, A.E.Brennemann and R.T.C.Tsui.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 173-83 (April, 1960).

Evaporated tin films of low residual resistivity have been produced by using very high deposition rates in a conventional vacuum system. The substrates were cooled with liquid nitrogen. After the film edges are removed by mechanical trimming or chemical etching, these films show sharp magnetic and temperature transitions from the superconducting to the normal state, a critical field-temperature characteristic which is close to a modified version of the London theory, a transition temperature very close to the value of bulk tin, and a reversible resistance-critical current characteristic. These characteristics are compared with those of films deposited on substrates at room temperature using low deposition rates. Evidence is presented to indicate that the edge effect in the temperature transition of films is caused by a concentration of impurities in the edges. The low-temperature mean free path, rather than the resistivity ratio, is suggested as a figure of merit for estimating film purity because the size effect limits the resistivity ratio for thin films.

536.48

10855 ON THE INFLUENCE OF AGGREGATION ON THE MAGNETIC PHASE TRANSITION OF EVAPORATED SUPERCONDUCTING THIN FILMS.

M.E.Behrndt, R.H.Blumberg and G.R.Giedd.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 184-8 (April, 1960).

An investigation was made of the magnetic phase transition of thin, superconducting Sn films. In evaporated films, because of the sloping edges, broad magnetic field transitions are generally found. This paper shows that such "penumbra" effects can be eliminated by raising the temperature of the substrate during evaporation. The lack of penumbra effect was due to the aggregation of the film. The transition curves of such films displayed hysteresis.

536.48 : 539.2 : 538.2

RELATIONS BETWEEN SUPERCONDUCTORS AND FERROMAGNETS. See Abstr. 10111

536.48

10856 He^3 CRYOSTATS.

V.P.Peshkov, K.N.Zinov'eva and A.I.Filimonov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1034-7 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 734-6 (Oct., 1959).

Systems are described which permit the attainment and maintenance of temperatures below 1°K by pumping out He^3 vapour. Temperatures down to 0.3°K were obtained in a transparent glass system having a volume of approximately 1 cm^3. Temperatures of 0.5°K and higher were maintained, in the presence of a heat influx of 7×10^{-4} W, in a continuously-operating metal apparatus containing 140 cm^3 of liquid He^4.

536.48 : 539.2 : 538.2

RECENT RESULTS FROM MEASUREMENTS OF MAGNETIC TEMPERATURES BETWEEN 1 AND 24°K. See Abstr. 10103

536.48 : 539.2

HYPERFINE COUPLING IN FERROMAGNETICS. See Abstr. 9891

536.48 : 539.2

HYPERFINE COUPLING IN METALS. See Abstr. 9860

536.48 : 539.14

10857 A DEVICE FOR OBTAINING VERY LOW TEMPERATUR AND ORIENTING NUCLEI.

A.V.Kogan, N.M.Reinov, I.A.Sokolov and M.F.Stel'makh.

Zh. tekh. Fiz., Vol. 29, No. 8, 1039-47 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 946-53 (Feb., 1960).

The use of adiabatic demagnetization for obtaining very low

nperatures is discussed, and an apparatus of this kind described
ly, together with details of the temperature-measuring technique
ed. An account is included of an associated apparatus for investi-
tions with oriented nuclei. S.A.Ahern

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

537.2

10858 AN INVESTIGATION OF THE PROCESS OF ELECTRIFICATION OF CRYSTALLIZING WATER.

G.Kachurin and V.I.Bekryaev.
kl. Akad. Nauk SSSR, Vol. 130, No. 1, 57-60 (Jan. 1, 1960).
Russian.

The charge division that occurs near the boundaries of a phase
nsformation in a substance is an important factor in problems of
nospheric electricity such as lightning protection of transmission
es, radio noise elimination etc. Experiments are described in
ich a drop of water is held on a wire loop and lowered into a cen-
l shaft in a thermostat whilst remaining at the focus of a micro-
ope, the microscope being connected with a cine camera. The other
d of the wire is joined either to an electrometer or, via an ampli-
r, to an oscilloscope. Photographs show the stages of crystalli-
tion and bursting of a drop. Some drops burst on crystallization
d produce a significant charge, others do not. A table gives the
arge of 70 bursting drops of 0.2 to 2 mm diameter at -3 to -20°.
e results are of the same order as obtained for thunder clouds.
D.E.Brown

537.2

10859 INFLUENCE OF IRRADIATION WITH β RAYS ON THE ELECTRIFICATION OF KCl CRYSTALS. A.Szaynok.

appl. Phys., Vol. 31, No. 3, 451-3 (March, 1960).

The measurements of electrical charges on dust clouds of
ushed KCl monocrystals previously irradiated with β-rays shows
at the value of the mean charge depends on irradiation time. In
e case of KCl irradiated with β-rays, a photoelectric effect is not
bserved, despite the presence of F centres.

537.2

10860 CONTACT CHARGING OF IRRADIATED POLYETHYLENE. S.Kittaka and A.Kasai.

appl. Phys. Japan, Vol. 29, No. 1, 27-31 (Jan., 1960). In Japanese.

The contact charging in vacuum between polyethylene irradiated
n an atomic pile and metal has been investigated. By successively
ringing them into contact and then separating, the charge on
olyethylene increases, at first rapidly then gradually, to its
aturation. This seems to be due to an equilibrium being established
y the successive transition of charge through the interface in one
ay in coming into contact and back in the other in separation. The
aturation charge with one unit of dose (50×10^6 r) of radiation is
egative, the amount of which increases at first with every additional
ose, then decreases to the initial small amount at 9 units of dose
nd eventually becomes a small positive charge at 72 units of dose.
he saturation value varies with the work function of the metal.
ence a conclusion may be drawn that the change in the contact
harge with the irradiation corresponds to the change in effective
ork function of polyethylene caused by formation and transition of
lectron trapping states in the irradiated polyethylene.

537.2 : 541.18

CHARGE OF SUBMICRONIC PARTICLES IN IONIZED ELECTRIC IELDS. MEASUREMENT OF THE SPEED OF PRECIPITATION OF HESE PARTICLES IN A UNIFORM ELECTRIC FIELD.

ee Abstr. 10361

537.2

10861 VAN DER WAALS FORCES IN AN INHOMOGENEOUS DIELECTRIC. I.E.Dzyaloshinskii and L.P.Pitaevskii.

h. eksper. teor. Fiz., Vol. 36, No. 6, 1797-805 (June, 1959).
Russian. English translation in: Soviet Physics—JETP (New
ork), Vol. 36(9), No. 6, 1282-7 (Dec., 1959).

The non-additive part of the free energy of an inhomogeneous
electric, related to the presence of long wavelength fluctuations
of the electromagnetic field in it, is calculated with the aid of the diagram technique. The corresponding part of the stress tensor (the van der Waals force stress tensor) is also calculated. In addition, formulae for the Green's functions of an electromagnetic field in an absorbing medium are adduced.

537.2 : 537.3

10862 MEAN VALUES OF THE PARAMETERS OF INHOMOGENEOUS MEDIA. I.A.Korneenko.

Zh. tekh. Fiz., Vol. 30, No. 1, 44-8 (Jan., 1960). In Russian.

Formulae are derived from the Green's theorem from which mean values of certain parameters (e.g. permittivity, electrical conductivity) can be obtained. Special cases discussed include those of laminar and spherical inhomogeneities. G.A.Chisnall

537.2 : 538.1

10863 MODELLING METHODS FOR ELECTRIC AND MAGNETIC FIELDS. G.I.Dimov.

Zh. tekh. Fiz., Vol. 29, No. 5, 668 (May, 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 5, 595 (Nov., 1959).

A magnet model for modelling electrostatic systems, (as well as magnetic systems) including electron-optical systems, is discussed. The method suggested gives the pattern of the lines of force of an axially symmetrical magnetic field. C.F.Barnaby

537.2 : 538.56

10864 USE OF SLOW SURFACE WAVES TO MEASURE THE DIELECTRIC SUSCEPTIBILITY OF MATERIALS AT ULTRA-HIGH FREQUENCIES. II. V.P.Shestopalov and K.P.Yatsuk.

Zh. tekh. Fiz., Vol. 29, No. 9, 1090-9 (Sept., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 9, 996-1004 (March, 1960).

For Pt I see Abstr. 3718 of 1960. The results of Pt I are extended to the case of liquid dielectrics. Formulae are obtained for ϵ in the case in which the helix is completely submerged in a liquid, and in the case in which the liquid is located in a dielectric tube on which the helix is wound. The effect of the periodicity of the helix on the accuracy of the measurement of ϵ is indicated. Experimental data verify the present theoretical analysis.

537.2

10865 USE OF SLOW SURFACE WAVES FOR MEASURING THE DIELECTRIC SUSCEPTIBILITY OF A MATERIAL AT ULTRA-HIGH FREQUENCIES. III.

V.P.Shestopalov, K.P.Yatsuk and I.P.Yakimenko.
Zh. tekh. Fiz., Vol. 29, No. 11, 1330-8 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1223-30 (May, 1960).

The method of measuring dielectric susceptibilities by means of a helix wave-guide is extended to the case in which the dielectric is lossy. For small losses ($\epsilon'' < \epsilon'$) formulae are obtained which make it possible to determine tan δ for solid samples of cylindrical shape and tan δ for liquids which fill a cylindrical tube, upon which the helix is mounted. The experimental results verify the theoretical predictions.

537.2 : 621.317.733

10866 R.F. ADMITTANCE BRIDGE FOR LIQUID-DIELECTRIC MEASUREMENTS. R.G.Bennett.

J. sci. Instrum., Vol. 37, No. 6, 195-7 (June, 1960).

An admittance bridge is described suitable for the measurement of the complex permittivity of liquid dielectrics at frequencies between 100 kc/s and 3 Mc/s. The unknown capacitance is compared directly with a standard capacitor, while the conductance arm may be simply calibrated on a direct current supply. Component values are given suitable for use with a cell having an empty capacitance of 5 pF. No Wagner earth is necessary when using a 3-terminal cell, since the balance condition is independent of admittances between the electrodes and the guard electrode.

537.2 : 532.7

WAVEGUIDE INTERFEROMETER FOR DIELECTRIC STUDIES OF DILUTE SOLUTIONS. See Abstr. 10664

CURRENT ELECTRICITY

ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

537.3 : 621.382

10867 THE OPERATION OF "ATOMIC" CURRENT SOURCES WITH DOUBLE ENERGY-CONVERSION.
V.S.Vavilov, B.M.Vul, G.N.Galkin and S.A.Fridman.
Fiz. tverdogo Tela, Vol. 1, No. 5, 826-7 (May, 1959). In Russian.

This paper examines a double-conversion scheme due to other workers, and briefly reported elsewhere [Elect. Engng, Vol. 76, No. 4, 361 (April, 1957)]. ZnS, CdS phosphors have greater stability against radiation damage than Si p–n junctions, so the radioactive source ($Sr^{90}-Y^{90}$ or Pm^{147}) is embedded in a phosphor, the photons from which activate the p–n junction in an adjoining layer. From a Sr source of strength 200 mc, an output of 1.54μA at 138 mV was obtained. I.D.C.Gurney

537.3

10868 BETA PARTICLE TRANSMISSION CURRENTS IN SOLID DIELECTRICS. B.Gross, A.Bradley and P.Pinkerton.
J. appl. Phys., Vol. 31, No. 6, 1035-7 (June, 1960).

The current from a beta particle source measured through a thin dielectric cannot be predicted simply from the absorption curve. A model is considered in which the space charge formation in the medium results in a component of current in addition to that of the betas transmitted. Calculations developed from this model give a close approximation to experimental results.

537.3 : 537.2

ELECTRICAL CONDUCTIVITY OF INHOMOGENEOUS MEDIA. See Abstr. 10862

IONIZATION

537.56

10869 EQUIVALENCE OF THE LANDAU AND FOKKER–PLANCK COLLISION TERMS. J.Enoch.
Phys. of Fluids, Vol. 3, No. 3, 353-4 (May-June, 1960).

It is shown that the Landau collision term is equivalent to the Fokker–Planck type collision term as derived on the basis of the assumption that binary collisions predominate.

537.56

10870 ELECTRIC FIELD DISTRIBUTIONS IN AN IONIZED GAS. II. B.Mozer and M.Baranger.
Phys. Rev., Vol. 118, No. 3, 626-31 (May 1, 1960).

For Pt I, see Abstr. 13386 of 1959. A method previously described is used to calculate the probability distribution of the low-frequency component of the electric field at a neutral point, the distribution of the low-frequency component at an ion, and that of the high-frequency component at an electron. The results are compared with those obtained by other authors.

537.56

10871 EXPERIMENTAL DETERMINATION OF THE INDIVIDUAL SECONDARY IONIZATION COEFFICIENTS IN HYDROGEN AND THEIR DEPENDENCE ON CATHODE WORK FUNCTION.
F.Llewellyn Jones and E.Jones.
Proc. Phys. Soc., Vol. 75, Pt 5, 762-71 (May, 1960).

This paper describes measurements of the formative time lag to breakdown in hydrogen in uniform electric field for a range of E/p from 50 to 250 V $cm^{-1}(mm\,Hg)^{-1}$. The preliminary work showed that the time lag was critically dependent upon the state and nature of the cathode surface. The formative time lags were therefore measured with different cathode surfaces, and the state of each surface was specified by measuring its work function. Previous work in this laboratory has shown that measurements of formative time lags can be analysed in terms of Davidson's current-growth equation to yield determinations of the individual secondary ionization coefficients. A similar analysis was carried out of the results of the present experimental data, and it was found that if the cathode work function was decreased by 0.25 eV, the magnitudes of the secondary coefficients were increased by a factor of two.

537.56

10872 CROSS SECTIONS FOR PHOTOIONIZATION FROM VALENCE-ELECTRON STATES.
A.Burgess and M.J.Seaton.
Rev. mod. Phys., Vol. 30, No. 3, 992-3 (July, 1958).

Numerical calculations have been made by a method based on that of Bates and Damgaard (1949) for $(l, l') = (0, 1), (1, 0), (1, 2), (2, 1), (2, 3)$ and $(3, 2)$ and $(l + 1) \leq n_l^* \leq 12$, and have been fitted by a general analytical expression whose coefficients are tabulated. J.Hawgood

537.56

10873 THE EFFECT OF ELECTRIC FIELDS ON THE TEMPERATURE THRESHOLD OF THE APPEARANCE OF POSITIVE IONS DURING SURFACE IONIZATION OF ATOMS.
É.Ya.Zandberg.
Zh. tekh. Fiz., Vol. 30, No. 2, 206-15 (Feb., 1960). In Russian.

When investigating the shifting of the near-threshold sections of the temperature dependences of K and CsCl surface ionization on W, caused by external electric fields up to 7 mV/cm, it was found that, for equal coefficients of surface ionization at near-threshold temperatures, the relation between $\sqrt{E}$ (E is the field strength) and T (temperature) is rectilinear. This finding bears out the Schottky law on decrease of the heat of evaporation of ions from surface. It is possible to use the shifts of the temperature thresholds to determine the heats of evaporation of ions in the case of elements for which the ionization potential is less than the minimum work function of an inhomogeneous surface. The heat of evaporation of K^+ from W was calculated to lie within 2.0-2.4 eV. F.Lachman

537.56

10874 DETERMINATION OF THE IONIZATION POTENTIAL OF URANIUM BY A SURFACE IONIZATION METHOD.
I.N.Bakulina and N.I.Ionov.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1001-5 (April, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 4, 709-12 (Oct., 1959).

A method is described for determining the difference in ionization potentials for two different atomic species which are ionized simultaneously on a heated metal surface. The method was verified by measuring the ionization potentials of sodium and lithium, and then measuring the difference in ionization potentials of uranium and lithium. The ionization potential of uranium is found to be 6.08 ± 0.08 V. At high temperatures, the positive ion currents for sodium, lithium, and uranium are found to vary in accordance with the theoretical expressions for surface ionization.

537.56

10875 SOME OXYGEN IONS FORMED AT HIGH PRESSURES IN A MASS SPECTROMETER. W.McGowan and L.Kerwi
Canad. J. Phys., Vol. 38, No. 5, 642-51 (May, 1960).

The oxygen ions formed by electron bombardment and collision processes in the mass spectrometer at pressures of about 10^{-3} mm Hg are examined. Mass spectrum lines due to O^+, O_2^+, O_3^+, and O^{++} as well as Aston bands due to O^+, O_2^+, and O_2^{++} are found. Processes leading to these species, as well as abundances and appearance potentials, are considered.

537.56

10876 ION–MOLECULE REACTIONS IN MASS SPECTROMETRIC STUDIES OF ALKALI HALIDE SALTS.
T.A.Milne.
J. chem. Phys., Vol. 32, No. 4, 1275-7 (April, 1960).

The contribution of ion–molecule reactions in the formation of complex ions during the evaporation of alkali halides is discussed. Results obtained with NaCl and KCl are presented. G.I.W.Llewelyn

537.56

10877 THE EXISTENCE OF THE NEGATIVE NITROGEN ION. Ya.M.Fogel', V.F.Kozlov and A.A.Kalmýkov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1354-6 (May, 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 36(9), No. 5, 963-4 (Nov., 1959).

A beam formed by the passage of positive nitrogen ions through a gaseous target has been found to contain small amounts of negativ nitrogen ions. The cross-section for the $N^+ \rightarrow N^-$ process is estima as 1.9×10^{-22} cm^2. No negative molecular nitrogen ions are observ

537.56

10878 MECHANISM OF SURFACE IONIZATION OF ATOMS OF THE ALKALI EARTH METALS. Yu.K.Szhenov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 336-9 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 239-41 (Feb., 1960).

The concurrent surface ionization of the alkali earth metals and of sodium on incandescent tungsten was investigated with a mass spectrometer. The ionization coefficients were found to be significantly higher when oxygen was circulated over the tungsten. The results are explained on the basis of the Saha—Langmuir theory. The specific character of the ionization of alkali earth metals when the tungsten is oxidized is related to the evaporation of molecules of the oxides of these metals from the surface.

537.56

10879 MONTE CARLO CALCULATIONS OF THE MOTIONS OF ELECTRONS IN HELIUM. T.Itoh and T.Musha.
J. appl. Phys., Vol. 31, No. 4, 744-5 (April, 1960).

Computed values of the ionization coefficient, excitation coefficients, drift velocity and mean energy of electrons in He for $40 \leq E/p \leq 160$ V/cm mm Hg, resulting from Monte Carlo calculations using a digital computor, are given. J.Dutton

537.56

10880 THE EXCITATION MECHANISM OF Ar$^+$ IONS OF 5-24 keV IN He, Ne, Ar, Kr, Xe.
T.J.M.Sluyters and J.Kistemaker.
Physica, Vol. 25, No. 2, 182-4 (Feb., 1959).

An apparatus is described for studying charge exchange and ionization cross-sections for, and intensity and spectral composition of the light emitted from, a beam of A$^+$ ions passing through a noble gas. The arc and spark spectra observed for a beam current $\sim 1\mu$A and a gas pressure of 10^{-2} mm Hg are tabulated, and graphs of the excitation functions of the A II line λ 4658 given and briefly discussed. J.Dutton

537.56

10881 INVESTIGATION OF PARTICLE COLLISIONS AT ENERGIES BETWEEN 6 AND 30 keV. R.Hölz.
Z.Naturforsch., Vol. 15a, No. 3, 211-19 (March, 1960). In German.

To study the transfer of energy in ionic collision phenomena, the range of hydrogen, helium and neon ions was measured in hydrogen and deuterium. At the low energy end of the region the range of all ions is greater in deuterium and hence the kinetic energy transfer in a collision is correspondingly smaller. At higher energies this relationship is reversed for the heavy ions. The results are in good agreement with the theoretical treatment of Bohr. S.J.St-Lorant

537.56

10882 INVESTIGATION OF DE-IONIZATION WITH PROBES AND BY A PHOTOELECTRIC METHOD.
N.A.Popov and E.A.Afanas'eva.
Zh. tekh. Fiz., Vol. 29, No. 7, 845-51 (July, 1959). In Russian. English translation in Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 764-9 (Jan., 1960).

Comparison of the probe method with a photoelectric method, (involving the use of a photomultiplier and an oscilloscope), for investigating the de-ionization of a gas in the post-discharge period, shows that in principle the first method can be replaced by the second which does not affect the discharge and allows continuous observation. Measurements were made in Kr (p = 1.5 mm Hg, discharge current 15 mA), and H$_2$ (p = 1.1 mm Hg, discharge current 4 mA). In the first gas the square root of the reciprocal of the intensity of radiation accompanying recombination is a linear function of time, as is also the reciprocal of the positive ion concentration for $t > 200\ \mu$sec, indicating intense volume recombination and yielding a value of 3×10^7 cm^3 ion^{-1} sec^{-1} for the recombination coefficient. In H$_2$ however, the logarithm of the total radiation intensity and that of the intensities of H$_\beta$-, H$_\gamma$-, and H$_\delta$-lines is a linear function of time, the corresponding de-ionization time constants being 2.7, 2.4, 2.5 and 2.6 msec respectively. I.C.Demetsopoullos

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ELECTRIC DISCHARGES

537.52

10883 HIGH-ENERGY DENSITIES BEFORE DWELL IN ELECTRICALLY EXPLODED WIRES.
F.H.Webb, Jr, H.H.Bingham and A.V.Tollestrup.
Phys. of Fluids, Vol. 3, No. 2, 318-19 (March-April, 1960).

Describes experiments on the explosion of 0.29 inch long 1 mil diameter Al, Cu and Ag wires, produced by the discharge through them, and the circuit inductance of $0.036\ \mu$H, of a $0.017\ \mu$F condenser charged initially to 18 kV. Curves of voltage, current, radius of luminous zone, energy, energy density E, and impedance versus time ($0\text{-}8 \times 10^{-8}$ sec) are given. Values of $E > 10$ eV/atom have been obtained in the initial stages. Photographs of the explosion for times from 17 to 119 nanosec are given. J.Dutton

537.52 : 621.387

10884 STUDY OF THE INFLUENCE OF A MAGNETIC FIELD ON THE INTENSITY OF LINES EMITTED BY SOME DISCHARGE TUBES. O.Tardy and M.R.Lennuier.
J. Phys. Radium, Vol. 19, Suppl. No. 7, 75A-83A (July, 1958). In French.

In fields of several thousands of gauss, an important increase in the intensity of the radiations is observed. The increase is not generally the same for all the lines radiated by a given tube; the electric power consumed by it also increases, but in a lesser ratio, in such a way that the luminous efficiency increases by a factor of about 2.

537.52

10885 PRE-BREAKDOWN PHENOMENA IN UNIFORM FIELDS.
D.T.A.Blair, F.M.Bruce, J.E.Matthews and D.J.Tedford.
Proc. Phys. Soc., Vol. 75, Pt 5, 729-32 (May, 1960).

Observations were made of pre-breakdown phenomena in uniform field gaps under ambient atmospheric conditions and measured irradiation intensities, in which current and light pulses were recorded. From measurements of the current-pulse duration a value for the mobility of positive ions of 2.6 cm^2 sec^{-1}V^{-1} was obtained at field strengths approaching the breakdown value.

537.52 : 621.387

10886 NEGATIVE CURRENT—VOLTAGE CHARACTERISTICS IN HYDROGEN AT HIGH PRESSURE USING PLANE PARALLEL ELECTRODES.
D.J.DeBitetto, L.H.Fisher and A.L.Ward.
Phys. Rev., Vol. 118, No. 4, 920-3 (May 15, 1960).

In conjunction with measurements of current—voltage characteristics in hydrogen, a few characteristics were obtained which include a region with negative slope. The latter characteristics were obtained with plane parallel electrodes at an electrode separation of 2 cm at a pressure of 400 mm Hg and with three values of externally initiated cathode-current. The initial currents ranged from about 10^{-11} to 10^{-9} A, and the amplified currents reached values as high as 10^{-4} A. The characteristics corresponding to the larger initial currents become negative at large currents ($\sim 10^{-5}$ A). The voltage at which a characteristic becomes negative, i.e. the maximum attainable voltage across the electrodes, decreases slightly with increasing initial current. The circuit included a series resistor of 20 megohms. These characteristics can be explained quantitatively on the basis of the first and second Townsend coefficients (previously measured with the same apparatus) acting in conjunction with space charge, if a not unreasonable discharge area is assumed. These calculations were carried out on an I.B.M. 704 computer.

537.52

10887 SOME SPARKOVER PHENOMENA WITH ENCLOSED GAPS. A.Aked, F.M.Bruce and C.Gordon.
Proc. Phys. Soc., Vol. 75, Pt 5, 733-8 (May, 1960).

The (percentage breakdown, voltage) curves obtained by applying $1/50\mu$ sec impulse voltages to an enclosed unventilated and non-irradiated uniform field gap were examined and compared with curves obtained under a variety of conditions of ventilation. In the course of the investigations both straight and stepped spark paths were observed, and preliminary results of an investigation of this phenomenon are described.

537.52 : 621.319.5

10888 SUPPRESSION OF COUNTER-EMISSION IN COMPRESSED AIR. APPLICATION TO HIGH-VOLTAGE GENERATORS AND ELECTROFILTERS. Nguyen-Trinh Dzoahn.
C.R.Acad. Sci. (Paris), Vol. 250, No. 10, 1811 (March 7, 1960).
In French.

A formula given previously (see Abstr. 7110 of 1960) is amended as a result of defining the rate of counter-emission, a term in the formula, explicitly. A.E.Kay

537.52

10889 THE INFLUENCE OF AN AMPLITUDE MODULATED H.F. FIELD ON THE HOMOGENEOUS POSITIVE COLUMN OF A D.C. DISCHARGE. M.Šicha.
Czech. J. Phys., Vol. 9, No. 2, 259-60 (1959). In Russian.

Investigations were made of the effect of an h.f. field, square-modulated at 50 c/s, on the intensity of light emitted from the discharge in neon at 2.1 mm Hg. In the space between the anode and the region where the h.f. field was applied, the variation of light intensity had the form of a stationary wave damped in the direction of the anode. Thus, while the continuous h.f. field results in stationary striations of the positive column, the pulsed h.f. field of the same type results in a wave of striations. Z.Krasucki

537.52

10890 A NEW TYPE OF MOVING STRIATIONS IN NEON [GLOW DISCHARGES]. L.Pekárek and M.Novák.
Czech. J. Phys., Vol. 9, No. 3, 401-2 (1959). In German.

Briefly deals with oscillographic studies using neon at 2 mm Hg pressure (2-3 mA current). It is suggested that a particular type of striation is connected with the formation of Ne_2^+. J.D.Craggs

537.52 : 541.12

10891 CHEMICAL REACTIONS IN THE POSITIVE COLUMN OF A GLOW DISCHARGE.
H.Schüler, K.Prchal and E.Kloppenburg.
Z. Naturforsch, Vol. 15a, No. 4, 308-10 (April, 1960). In German.

A study of benzene vapour in a glow discharge (6 mA current, 25 V/cm field strength) with 1.5 mm Hg pressure of benzene and 1 mm Hg of He as a carrier gas. Gas chromatography was used and data are presented on the products of the reaction taking place in the discharge. J.D.Craggs

537.52 : 621.387

10892 ELECTRIC ARC WITH GLASS ELECTRODES.
I.Mihul and G.Tacu.
Bul. Inst. Politeh. Iasi, Vol. 4(8), No. 3-4, 129-34 (1958). In Roumanian.

Conditions necessary for starting and maintenance of an arc are discussed, for the case of glass or glass/metal electrodes with a.c. or d.c. The experimental set-up is described and c.r.o. photo-graphs of dynamic characteristics are shown and interpreted. 3 references. A.Reiss

537.52

10893 THE DECAY OF ARC DISCHARGES. I. THEORETICAL CONSIDERATION. G.Frind.
Z. angew. Phys., Vol. 12, No. 5, 231-7 (May, 1960). In German.

Summarizes first certain fundamental characteristics of arcs, e.g. the Elenbaas—Meller energy balance equation, the radial variation of temperature, and thermal conductivity coefficient variation with temperature (up to 20 000 °K for nitrogen), etc. Then temporal variations in a decaying arc plasma are treated analytically. J.D.Craggs

537.52

10894 MICROWAVE NOISE FROM LOW-PRESSURE ARCS.
R.M.Hill and S.K.Ichiki.
J. appl. Phys., Vol. 31, No. 4, 735 (April, 1960).

Noise from a 200 μ pressure neon discharge was measured in a waveguide, using a superheterodyne detector with a commercial noise tube as standard. The discharge current was pulsed, and of 6 μ secs duration. Detectable noise occured at the beginning of the pulse (8-12 kMc/s frequency range) and appears to be connected with arc initiation processes. J.D.Craggs

537.52 :·537.534

EMISSION OF RELATIVELY HIGH-ENERGY IONS FROM LOW-VOLTAGE ARCS. See Abstr. 9092

537.52 : 533.5 : 621.387

MECHANISM OF INERT GAS CLEANUP IN A GASEOUS DISCHARGE. See Abstr. 10703

PLASMA

537.56

10895 EQUATION OF STATE OF A PLASMA.
A.A.Vedenov and A.I.Larkin.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1133-42 (April, 1959). In Russian. English translation in: Soviet Physics-JETP (New York), Vol. 36(9), No. 4, 806-11 (Oct., 1959).

The free energy F of a completely ionized gas is given in terms of an expansion in the density n:

$$F = F_{\text{ideal}} + An^{3/2} + Bn^2 \ln n + Cn^2.$$

The term $An^{3/2}$ is identical with the familiar Debye—Hückel term. Expressions for B and C have been obtained. A diagram technique has been used to carry out the calculations.

537.56

10896 CONVECTIVE PINCH INSTABILITY.
B.B.Kadomtsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1096-101 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 780-3 (April, 1960).

An investigation is made of the stabilty with respect to axially symmetric perturbations, including entropy-wave perturbations, of a pinch with a distributed current.

537.56

10897 BOUNDARY-LAYER FORMATION IN THE PINCH.
J.Killeen, G.Gibson and S.A.Colgate.
Phys. of Fluids, Vol. 3, No. 3, 387-94 (May-June, 1960).

A study is made of various processes that occur prior to the pinch effect when an electric field is applied to a deuterium gas. The variables of the problem are the percentage of ionization, the electron and ion temperatures, the resistivity of the gas, and the current density. A one-dimensional problem is considered in which the above variables are determined as functions of one-space dimension and the time. The equations determining these variables are: the heat developed as the current flows through the gas equals the rate of increase of the internal energy of the plasma, the equation describing the rate of ionization, the equation describing the rate of transfer of energy from electrons to ions and the electromagnetic field equations. These equations are a generalization of the plasma equations solved by Wyld and Watson (1956) in that spatial dependence is included, i.e. a current layer is calculated instead of assuming a constant current. The equations are solved numerically using an IBM 704 computer.

537.56

10898 ON THE THEORY OF OHMIC HEATING OF A FULLY-IONISED PLASMA.
H.Schrade, W.Bez, K.H.Höcker and H.J.Kaeppeller.
Z. Naturforsch., Vol. 15a, No. 2, 155-68 (Feb., 1960). In German.

A detailed analytical treatment based on the Boltzmann equation. Electron—ion collisions are discussed in detail. J.D.Craggs

537.56 : 539.17

10899 HIGH-FREQUENCY HEATING OF A PLASMA CYLINDER IN AN AXIAL MAGNETIC FIELD.
K.Körper.
Z. Naturforsch, Vol. 15a, No. 3, 235-43 (March, 1960). In German.

The conditions are examined under which the effect of ion—electron scattering on radial oscillations near the ion resonance of an infinite plasma cylinder in an axial magnetic field may lead to a heating of the plasma, possibly sufficient to induce thermonuclear reaction. The magnetic field strengths needed to stabilize the plasma, and the density of the plasma necessary to guarantee a sufficient rate of reaction, require that the optical behaviour in the decimeter wavelength-range is considered. In an equivalent model for the supply circuit, the reaction of the plasma is taken into account in a quantitative manner. Because of the finite extent of the plasma a dense spectrum of eigen-resonances of the plasma system exits.

Therefore the matching of the external circuit to the plasma is possible only in the mean. Numerical results are given for the energy absorbed, the radiative energy penetrating the plasma cylinder and the corresponding reactive output, as functions of the plasma density the temperature and the frequency (which, near the "ion-resonance", is the geometric mean value between the gyrofrequencies of the ions and electrons), when the oscillator and the plasma are optimally matched.

537.56 : 538.3

DYNAMICS AND HEATING OF A CONDUCTING MEDIUM IN A MAGNETIC FIELD. See Abstr. 11035

537.56

10900 **THE IMPEDANCE OF A COIL WITH A PLASMA AS THE DIELECTRIC.** K.Körper.

Z. Naturforsch., Vol. 15a, No. 3, 226-35 (March, 1960). In German.

From the basic equations of magnetohydrodynamics, the energy conservation theorem for plasmas is derived for events periodic in time. In addition to the terms known from vacuum electrodynamics, there are the kinetic energies of the electrons and ions, and a term due to the oscillations of the electrons and ions in the magnetic field. With the help of the solution for a radially oscillating cylinder, the impedance of a coil containing the plasma is derived from general energy considerations. The impedance is discussed and its mean value in the range between two eigenfrequencies of the plasma cylinder is given.

537.56

10901 **FOURIER ANALYSIS OF THE ELECTRIC MICRO-FIELD IN A PLASMA. II.** G.Hettner and H.Wagner.

Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 7-8, 405-13 (1960). In German.

Sequal to earlier paper (Abstr. 11157 of 1959) taking into account effects of large curvature of electron paths caused by Coulomb interactions. A Gaussian distribution for the Fourier amplitudes is found again, which is displaced towards higher amplitudes at high frequencies. B.Meltzer

537.56

10902 **IONIZATION TIMES OF IMPURITIES IN HYDROGEN PLASMAS.** R.W.P.McWhirter.

Proc. Phys. Soc., Vol. 75, Pt 4, 520-5 (April 1, 1960).

The problem discussed is the calculation of the time it takes for impurity atoms and ions to become ionized in the hydrogen plasma produced in pulsed thermonuclear machines. Classical ionization cross-sections are used to calculate ionization rates and the effect of radiative recombination is included. The importance of taking into account the time dependence of the state of ionization is illustrated by an example where the energy radiated by an impurity of carbon is estimated. The time for impurity ions to reach the steady state is compared with the duration of the discharge for a number of operating thermonuclear machines and it is found that the latter times are too short for the steady state to be established. The assumption of the steady state is shown to be acceptable for a power producing D—D reactor.

537.56 : 539.2 : 537.311

10903 **THE INFLUENCE OF COLLISIONS BETWEEN ELECTRONS ON THEIR VELOCITY DISTRIBUTION IN GASES AND IN SEMICONDUCTORS IN AN ELECTRIC FIELD.** A.V.Gurevich.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 304-6 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 215-16 (Jan., 1960).

In highly ionized gases (plasma), electron—electron collisions affect the electron velocity distribution. The distributions are computed for a large range of a parameter that characterizes the influence of the interelectronic collisions. The results lie between the Maxwellian and Druyvestein distributions. D.Walsh

537.56

10904 **EXPERIMENTAL DEPENDENCE OF THE COLLISION-FREE SHOCK THICKNESS UPON ALFVÉN MACH NUMBER.** R.M.Patrick.

Phys. of Fluids, Vol. 3, No. 2, 321-3 (March-April, 1960).

The thickness and speeds of oblique collision-free shocks in a hydrogen plasma were obtained by measuring the time variation of radiated light intensity at viewing ports in the shock tube; the densities behind the shocks were obtained by measuring the visible bremsstrahlung intensity. The shock speeds were of order 3×10^7 cm/sec and the thicknesses of order 4 cm. The results are presented by plotting the ratio of the shock thickness to the cyclotron radius of an ion moving with the Alfvén speed ahead of the shock against the Alfvén Mach number M_A (ratio of shock speed to Alfvén speed ahead of shock). The results indicate that this dimensionless shock thickness ratio is a strongly decreasing function of M_A in the range studied ($1.5 \le M_A \le 3$). It is pointed out that the gas density must exceed a certain value to ensure sufficient photo-ionization ahead of the shock. O.Penrose

537.56

10905 **HYDRODYNAMIC MODEL OF DIFFUSION EFFECTS ON SHOCK STRUCTURE IN A PLASMA.**

O.W.Greenberg, H.K.Sen and Y.M.Treve.

Phys. of Fluids, Vol. 3, No. 3, 379-86 (May-June, 1960).

Diffusion effects on the structure of a steady, plane shock in a proton—electron plasma have been studied using a simplified, two-fluid, hydrodynamic model in which diffusion is the only shock broadening mechanism. Charge separations occur inside the shock because of the mass difference between protons and electrons. The shock is shown to have electric field and density oscillations as a function of distance through the shock. The peak electric fields are large; the peak electric field inside a weak shock of Mach 1.169 reaches 41 700 V/cm for typical quiescent plasma conditions. The distance in which electric field changes occur is of the order of ten Debye lengths of the quiescent plasma. The present work is limited to shocks of Mach number less than 2.

537.56 : 523.16

RADIO EMISSION FROM PLASMA SHOCKS. See Abstr. 10480

537.56

10906 **PASSAGE OF PARTICLES THROUGH A PLASMA.** A I.Larkin.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 264-72 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 186-91 (Jan., 1960).

The Green's function method and the diagram technique are used to calculate the energy loss per unit time by a particle passing through a plasma. Numerical values of the factors in the argument of the logarithm have been obtained for limiting cases.

537.56 : 537.534

MOTION OF A RELATIVISTIC CHARGED PARTICLE IN THE MAGNETIC FIELD PRODUCED BY A CONSTANT CYLINDRICAL [DISCHARGE] CURRENT OF A RAREFIED PLASMA. See Abstr. 10982

537.56

10907 **ACCELERATION OF PLASMOIDS BY HIGH-FREQUENC ELECTRIC FIELDS.** M.A.Miller.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1909-17 (June, 1960). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1358-63 (Dec., 1959).

The possibility of accelerating completely ionized quasi-neutral plasmoids in moving high-frequency potential wells is indicated. If such wells are formed by two fields of different frequency, the plasmoids can be accelerated by changing the frequency of one of the fields or by using a waveguide of variable cross-section. Certain features of linear and cyclical plasma accelerators are analysed.

537.56

10908 **PENETRATION OF AN ELECTROMAGNETIC FIELD INTO A PLASMA.** K.N.Stepanov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1457-60 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1035-6 (Nov., 1959).

The depth of penetration into a semi-infinite plasma in a magnetic field perpendicular to the plasma boundary is calculated.

537.56

10909 **DYNAMICS OF A CONDUCTING GASEOUS SPHERE IN A QUASI-STATIONARY ELECTROMAGNETIC FIELD.**

V.V.Yankov.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 224-8 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 158-60 (Jan., 1960).

A theoretical investigation is made of the small oscillations of a plasma sphere of infinite conductivity.

537.56

10910 EQUILIBRIUM OF A PLASMA TOROID [WITH DISTRIBUTED CURRENT] IN A MAGNETIC FIELD.

V.D.Shafranov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1088-95 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 775-9 (April, 1960).

537.56

10911 THE STABILITY OF A CYLINDRICAL PLASMA CONDUCTOR WITH VOLUME CURRENT.

Yu.V.Vandakurov and K.A.Lur'e.

Zh. tekh. Fiz., Vol. 29, No. 9, 1170-3 (Sept., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 9, 1068-71 (March, 1960).

The problem is tackled theoretically using the hydromagnetics of incompressible fluids. Expressions, which favour stability, are derived for the variation of the magnetic field inside the plasma with radius. In some cases, stability is greater without volume currents. A.H.Gabriel

537.56 : 538.3

10912 COLLISION-FREE HYDROMAGNETIC DISTURBANCES OF LARGE AMPLITUDE IN A PLASMA.

J.H.Adlam and J.E.Allen.

Proc. Phys. Soc., Vol. 75, Pt 5, 640-8 (May, 1960).

Calculations are given of certain collision-free hydromagnetic disturbances produced by the rapid compression of a plasma containing a magnetic field.

537.56 : 538.56

10913 A METHOD OF DETERMINING THE ELECTRON DENSITY OF A PLASMA BY MEANS OF THE GROUP VELOCITY.

T.Consoli and D.Lepechinski.

C. R. Acad. Sci. (Paris), Vol. 250, No. 15, 2694-6 (April 11, 1960). In French.

A study of the group velocity in a region where the frequency is lower than the plasma frequency shows that a maximum occurs at a frequency of about one quarter that of the electron cyclotron frequency. This maximum is fairly flat, so that the group velocity is very sensitive to the electron density and the field strength, but not to the actual value of frequency being used. It is suggested that measurement of this group velocity should provide a means of measuring the electron density. A.H.Gabriel

537.56 : 538.18

10914 SPECTROSCOPIC INVESTIGATION OF AN INTENSE PULSED DISCHARGE IN HYDROGEN. III. DETERMINATION OF THE PARAMETERS OF A HIGH-TEMPERATURE PLASMA.

S.Yu.Luk'yanov and V.I.Sinitsÿn.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1621-4 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol.36(9), No. 6, 1155-7 (Dec., 1959).

For Pt II, see Abstr. 8005 of 1958. The results of a spectroscopic measurement of the parameters of a high-temperature plasma are presented. It is shown that, at the time of maximum compression, the density of charged particles along the axis of the discharge is 35-40 times greater than the original density of neutral atoms. The ionic temperature reaches one or two million degrees.

537.56 : 523.87

10915 SIMPLE METHOD FOR COMPUTING THE MEAN RANGE OF RADIATION IN IONIZED GASES AT HIGH TEMPERATURES.

Yu.P.Raizer.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1079-83 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 769-71 (April, 1960).

The optical absorption coefficients for multiply -ionized high-temperature gases are considered. A simple method is given by which it is possible to approximate rapidly the range of radiation averaged over the optical spectrum. This range determines the radiative thermal conductivity and emissivity of a gas at different temperatures and densities.

537.56 : 538.56

10916 MICROWAVE WHISTLER MODE PROPAGATION IN A DENSE LABORATORY PLASMA.

R.M.Gallet, J.M.Richardson, B.Weider, G.D.Ward and G.N.Harding.

Phys. Rev. Letters, Vol. 4, No. 7, 347-9 (April 1, 1960).

An attempt is described to employ microwave propagation techniques for diagnostic measurements on Zeta, using frequencies lower than the electron gyro frequency. Some qualitative results are given, indicating that such measurements may be practicable. Measurements at present in progress employ two frequencies, and from these it should be possible to determine the electron density and the magnitude and direction of the magnetic field. A.H.Gabriel

537.56

10917 RADIATION BY PLASMA OSCILLATIONS IN A BOUNDED PLASMA IN A MAGNETIC FIELD.

H.W.Wyld, Jr.

Phys. of Fluids, Vol. 3, No. 3, 408-15 (May-June, 1960).

The radiation by a thermal distribution of plasma oscillations in a bounded plasma in a magnetic field is calculated in the limit $(\omega_c/\omega_p)^{1/2} \ll 1$, where ω_c and ω_p are the cyclotron and plasma frequencies. The calculation is performed in two ways leading to the same result: (1) a "Fresnel formula" for ratio of the intensity of the electromagnetic wave transmitted through the plasma boundary to the intensity of an incident plasma oscillation is derived; (2) the decaying modes, satisfying a radiation condition at infinity, of a bounded plasma in a magnetic field are found. The results are compared with the synchrotron radiation by a plasma in a magnetic field. It is found that for a thermal distribution of plasma oscillations, the radiation due to plasma oscillations is small compared to the synchrotron radiation.

537.56

10918 RELATIVISTIC CALCULATION FOR CYCLOTRON RADIATION FROM HOT PLASMAS.

D.B.Beard.

Phys. of Fluids, Vol. 3, No. 2, 324 (March-April, 1960).

Some previous calculations (Abstr. 11164 of 1959) are refined so as to include relativistic effects. O.Penrose

537.56

10919 CORRECTION TO THE PAPER BY V.YA.EIDMANA "RADIATION OF AN ELECTRON MOVING IN A MAGNETOACTIVE PLASMA".

V.Ya.Eidmana.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1135-6 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 947 (Oct., 1959).

See Abstr. 7240 of 1958. Completes the normalization of the polarization vector $a_{j\lambda}$, and makes the necessary corrections to the equations affected.

537.56

10920 ELECTRON OSCILLATIONS IN A MAGNETIZED PLASMA.

A.Kildal.

Univ. Bergen Arbok, 1959, No. 17, 4-10.

The dispersion equation for electric waves in a plasma, propagated transverse to an external magnetic field, is derived by the use of Newton's second law and Maxwell's equations. This derivation is simpler than the usual one, which makes use of Boltzmann's equation.

537.56

10921 ELECTRON OSCILLATIONS IN A PLASMA.

A.A.Zaitsev, G.S.Leonov and I.A.Savchenko.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1332-4 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 944-6 (Oct., 1959).

Plasma oscillations were detected by moving a probe close to the boundary of an inert gas plasma. The maximum pressure that gave oscillations corresponded to the same value of electron mean free path for the gases tried (A, He and Xe). A standing-wave pattern of oscillation amplitude was observed when the probe was moved parallel to the discharge axis. Its period was equal to the electron velocity divided by the oscillation frequency, to a reasonable degree of accuracy. D.Walsh

537.56

10922 ANOMALOUS ELECTRON SCATTERING AND THE EXCITATION OF PLASMA OSCILLATIONS.

M.D.Gabovich and L.L.Pasechnik.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1025-33 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 727-33 (Oct., 1959).

A study was made of the interaction of an electron beam with an independently formed plasma, for the case where an appreciable change in the electron energy occurred and where plasma oscillations were excited. The observed data can qualitatively be interpreted by assuming that the electrons form clusters and that these clusters interact coherently with the plasma.

537.56

10923 CHARGED PARTICLE ENERGY LOSSES DUE TO EXCITATION OF PLASMA OSCILLATIONS.
Yu.L.Klimontovich.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1405-18 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 999-1007 (Nov., 1959).

Beam electrons and plasma oscillations are regarded as two subsystems. A kinetic equation describing the interaction between the beam and plasma is obtained on the assumption that the beam does not change the properties of the plasma and that the plasma state is specified by its equilibrium parameters. The expression for the decelerating force calculated on the basis of this equation includes losses due to electron—electron collisions as well as those due to the excitation of plasma oscillations. A more general case is considered in which neither of the subsystems is in thermal equilibrium. The solution of a set of nonlinear equations for the beam electron distribution function and the electric potential is considered for this particular case. The results are used to account for the rapid energy transfer from beam electrons to plasma electrons, which was first observed by Langmuir.

537.56

10924 INVESTIGATION OF ION CYCLOTRON RESONANCE IN A DENSE PLASMA. K.D.Sinel'nikov, V.T.Tolok, N.I.Nazarov, I.I.Bakaev, V.A.Bondarev and Yu.P.Bugai.
Zh. tekh. Fiz., Vol. 33, No. 3, 283-8 (March, 1960). In Russian.

The experiment was conducted in a straight discharge tube containing a hydrogen plasma with a density of 10^{12}-10^{14} ions/cm^3 and with a longitudinal magnetic field of 10^4 Oe. The dependence of the resonance absorption on a number of plasma parameters, such as pressure, current, etc., is demonstrated. H.C.Cole

537.56

10925 OSCILLATIONS OF A PLASMA IN A MAGNETIC FIELD AT FREQUENCIES CLOSE TO THE CYCLOTRON FREQUENCY. V.N.Lazukin.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 969-75 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 685-90 (Oct., 1959).

A description is given of a method used to observe oscillations of a plasma in a longitudinal magnetic field at frequencies several times smaller than the ion cyclotron frequencies. The method facilitates the observation of the oscillation spectrum in the form of a series of narrow lines with very high signal-to-noise ratio. It is suggested that the observed oscillations are analogous to the hydromagnetic waves predicted by plasma theory.

537.56

10926 RESONANCE IN A PLASMA WITH TWO ION SPECIES. S.J.Buchsbaum.
Phys. of Fluids, Vol. 3, No. 3, 418-20 (May-June, 1960).

When a high-density plasma column in an axial magnetic field possesses two (or more) ion species of different charge-to-mass ratios, there exists a plasma resonance condition which involves only the ion cyclotron frequencies. At resonance, the two ion clouds oscillate transversely to the static magnetic field and 180° out of phase with each other, while the electrons remain relatively motionless. The ratio of the ion oscillatory energy to that of the electrons is of the order of the ratio of the ion-to-electron masses. Collisions between the two ion clouds randomize the large ordered velocities of the ions with great efficiency. Thus, by exciting this resonance, considerable ion heating may be realized. The effect of varying the relative concentration of the two ions is discussed.

537.56

10927 OSCILLATIONS OF A NONUNIFORM PLASMA. E.S.Weibel.
Phys. of Fluids, Vol. 3, No. 3, 399-407 (May-June, 1960).

The oscillations of a plasma which is confined by an r.f. field are investigated. The confining potential is approximated as $\psi(x) = \frac{1}{2}m\omega_0^2x^2$. Longitudinal plasma oscillations in the x direction are determined from the self-consistent Boltzmann transport equation without the collision term (Vlasov equation). This equation is linearized about equilibrium velocity distribution $f_0 = \exp[-(\psi + \frac{1}{2}mv^2)/kT]$. By expanding the electric field in Hermite polynomials, it is possible to reduce exactly the resulting integro-differential equation to an infinite system of linear equations for the expansion coefficients. The resonant frequencies are the roots of the determinant of the system. The frequency spectrum so obtained is quite unlike those obtained for Sturm—Liouville problems. This spectrum contains the integral multiples of ω_0 as limit points. As $e^2n/m\omega_0^2 \to 0$, the resonant frequencies coalesce into these limit points, each of these frequencies $\mu\omega_0$(μ = integer) being infinitely degenerate. Since all frequencies are real, the oscillations are not damped. The resonant frequencies are determined approximately as functions of $e^2n/m\omega_0^2$ as the roots of principal sub-determinants of finite order N. This procedure converges rapidly with increasing N.

537.56

10928 OSCILLATION OF A PLASMA CYLINDER IN AN AXIAL MAGNETIC FIELD. II.
K.Körper.
Z. Naturforsch., Vol. 15a, No. 3, 220-6 (March, 1960). In German.

For Pt I, see Abstr. 361 (1959). Radial oscillations are excited in a homogeneous infinite plasma cylinder in a homogeneous axial magnetic field by a surface current which is homogeneous in the axial and azimuthal direction. The modes of oscillations corresponding to the axial and azimuthal components of current are not coupled, and so they may be analysed separately. The magnetic field in the plasma and vacuum is obtained, and the indices of refraction for both types of oscillations are discussed thoroughly. When the currents are parallel to the external magnetic field, the oscillations are characterized by the refractive index of Eccles. When the current is perpendicular to the magnetic field, two resonance frequencies exist, which depend on the density of the plasma and the magnetic field strength. In the latter case, the radial characteristic oscillations of the plasma cylinder in an external magnetic field are considered.

537.56

10929 STABILITY OF UNIFORM PLASMAS WITH RESPECT TO LONGITUDINAL OSCILLATIONS. P.D Noerdlinger.
Phys. Rev., Vol. 118, No. 4, 879-85 (May 15, 1960).

It is possible to relate the dispersion formula for longitudinal oscillations in an infinite, uniform, collision-free plasma with no magnetic field to the complex potential of a line charge distribution on the real axis of the phase velocity ($u = \omega/k$) plane. If the initial velocity distribution integrated over directions orthogonal to the direction of propagation if $f_0(v)$ the plasma is stable if and only if

$$U(u) = P\int_{-\infty}^{\infty} \frac{f_0'(v)dv}{v - u}$$

is negative at the minima of $f_0(v)$ on the real axis, with unimportant exceptions. In particular it is shown that single-peaked distributions are stable, while those with very sharp (e.g. nondifferentiable) minima or with a zero of f_0 between two peaks are not. The charge analogy yields information on the wavelengths for which oscillations can grow and on rates of growth. Examples are given, including the case of two identical interpenetrating hot plasmas. A limited generalization to transverse oscillations is given.

537.56

10930 THE APPEARANCE OF A "BACKWARD WAVE" IN A NON-MAGNETIZED, AIR-BOUNDED PLASMA CYLINDER.
W.O.Schumann.
Z. angew. Phys., Vol. 12, No. 4, 145-8 (April, 1960). In German.

Waves in which the phase and group velocities are in opposite directions can be set up in inhomogeneous plasmas when the electron density on the boundary is finite. If this density is characterized by ω_0, propagation starts at the low frequency limit $\omega_0/\sqrt{2}$.
A.H.W.Beck

537.56

10931 THE POSSIBILITY OF SELF-OSCILLATION OF CHARGE IN CROSSED FIELDS. Yu.N.Barabenenkov.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 263-5 (Jan., 1960). In Russian.

With linear damping, only transient oscillations appear in the motion of charge in crossed fields. With nonlinear damping, self-oscillation can be accomodated. The condition for this is given.
A.E.I.Research Laboratory

537.56 : 538.56

SCATTERING OF ELECTROMAGNETIC WAVES BY LONGITUDINAL PLASMA WAVES. See Abstr. 11053

ELECTRON EMISSION
ELECTRON BEAMS

537.533

10932 **A NEW RESULT ON THE DEGRADATION OF TITANATES IN AGREEMENT WITH THE EXO-EMISSION.** A.Koller and M.Beranek.
Czech. J. Phys., Vol. 9, No. 3, 402-3 (1959). In German.

Exo-electron emission is used to investigate the deterioration of strontium barium titanate dielectrics in steady fields. Trapping states are found which are assumed to arise from the effect of the atmosphere in which the ceramics are fired. (See Abstr. 4552 of 1959). G.F.J.Garlick

537.533

10933 INTERPRETATION OF THE FIELD-EMISSION IMAGES OF METAL-FILM CATHODES. V.N.Shrednik.
Fiz. tverdogo Tela, Vol. 1, No. 7, 1134-9 (July, 1959). In Russian.

The distribution of intensity in a field-emission pattern produced by an electron projector is governed both by the work function distribution and local variations of the electric field intensity at the object surface. The paper describes methods of distinguishing these two factors in the case of film cathodes Zr—W and Ba—W.
A.Tybulewicz

537.533 : 621.385.1

10934 THE ROLE OF CHEMICAL REACTIONS IN THERMIONIC EMISSION. G.M.Panchenkov and A.M.Kolchin.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 357-9 (March 11, 1960). In Russian.

On the basis of experiments which are very briefly described it is concluded that, at sufficiently low temperatures and for large concentrations of caesium in thin layers on the emitter, the emission is determined by conversion of caesium atoms as the result of a chemical reaction with the sub-layer and their ionization at the surface.
S.C.Dunn

537.533 : 621.385.032.213.13

10935 THERMIONIC EMISSION FROM BARIUM TUNGSTATE. A.I.Mel'nikov, A.V.Morozov, R.B.Sobolevskaya and A.R.Shul'man.
Fiz. tverdogo Tela, Vol. 2, No. 4, 704-8 (April, 1960). In Russian.

An account is given of measurements carried out on experimental diodes with W anodes and pressed Ba_3WO_6 powder cathodes, activated at various temperatures, T. The current—voltage characteristics were determined and Schottky temperatures were calculated. Richardson plots were constructed, the current density of cathodes, activated at various T, was measured, and the corresponding Richardson work function φ was determined. The temperature dependence of φ and the distribution of thermionic emission on the cathode surface were studied. The results, particularly the high (3.5 - 4) values of the measured temperature / Schottky temperature ratios, indicated that the Ba_3WO_6 cathodes have emission properties similar to those of semiconducting emitters. M.H.Sloboda

537.533

10936 **THERMIONIC EMISSION FROM NICKEL [AND PLATINUM] IN THE PRESENCE OF HALOIDS.**
E.I.Agishev and Yu.I.Belyakov.
Zh. tekh. Fiz., Vol. 29, No. 12, 1480-3 (Dec., 1959). In Russian.

A non-magnetic, pulse mass-spectrometer was used for studying thermionic emission from Ni and Pt in CCl_4 and Freon atmospheres. Contrary to the results reported by Sinel'nikov and Berkhoyer [Ucheni Zapiski Khar'kivskoho Unyversytetu, 117 (1955)], no O_2^+, H_3O^+, or other ions were detected in the diodes filled with halide-bearing substances, whose introduction resulted only in reducing the current of ions of the alkali metals present (in trace quantities) in Ni and Pt. M.H.Sloboda

537.533

10937 PHOTO-STIMULATED EMISSION OF EXO-ELECTRONS FROM THE SURFACE LAYER OF AMPHOTERIC METALS REACTING WITH CONCENTRATED SODIUM HYDROXIDE OR POTASSIUM HYDROXIDE. J.Wawrzyniak and B.Sujak.
Nature (London), Vol. 186, 467 (May 7, 1960).

Illumination of surfaces of amphoteric metals such as aluminium, zinc, tin and some alloys after spraying of freshly abraded surfaces with sodium or potassium hydroxide gives rise to strong exo-electron emission. No effect is found for iron, copper, bismuth, nickel, lead or magnesium under similar conditions. G.F.J.Garlick

537.533

10938 EMISSION OF AN OXIDE CATHODE UNDER BOMBARDMENT BY POSITIVE IONS. I.A.Abroyan.
Fiz. tverdogo Tela, Vol. 1, No. 12, 1854-6 (Dec., 1959). In Russian.

Describes experiments in which the electron current leaving an oxide-coated cathode is measured as a function of the bombarding positive ion current. Potassium ions of 1 - 10 keV and hydrogen ions of 5 - 70 keV were employed, the pressure in the vacuum system being of the order of 10^{-6} mm. It was found that for an activated cathode the ratio of electron current to ion current is not constant, but varies with both total ion current and energy. T.Mulvey

537.533

10939 ON THE EXPULSION OF ELECTRONS FROM GLASS BY IONS OF HELIUM AND ARGON.
G.M.Batanov and N.N.Petrov.
Fiz. tverdogo Tela, Vol. 1, No. 12, 1856-8 (Dec., 1959). In Russian.

The emission of electrons from metal surfaces under bombardment by ions of inert gases has been extensively studied by previous authors. This short paper is concerned with the emission of electron from an insulator (glass) under ion bombardment. A special tube was used in which a heated glass target could be bombarded with 10^{-8} A of argon or helium ions with energies up to 2 keV. The measured secondary emission coefficient is shown graphically. With argon ions secondary emission does not occur until the ion energy exceeds 300 eV. The application of this technique to the study of electronic structure of dielectrics and semiconductors is briefly mentioned.
T.Mulvey

537.533

10940 THE ROLE OF ELECTRONS INELASTICALLY SCATTERED FROM VARIOUS SUBSTRATES IN THE SECONDARY ELECTRON EMISSION OF THIN LAYERS OF NaCl.
M.V.Gomoyunova and G.A.Ivanov.
Fiz. tverdogo Tela, Vol. 2, No. 2, 319-30, (Feb., 1960). In Russian.

Layers of sodium chloride were deposited on substrates of various elements. It was found on electron bombardment that the magnitude of the secondary emission coefficient was always associated with the inelastic scattering coefficient of the substrate. Specific tests were undertaken to check this. It was concluded that the electrons inelastically scattered from the substrate play a leading part in producing secondary emission from the sodium chloride. A.E.I. Research Laboratory

537.533

10941 CHARACTERISTICS OF ENERGY LOSS ON REFLECTION OF ELECTRONS FROM SINGLE CRYSTALS OF ALKALI HALIDES. M.L.Kapitsa, S.A.Fridrikhov and A.R.Shul'man.
Fiz. tverdogo Tela, Vol. 2, No. 3, 517-23 (March, 1960). In Russian.

The fine structure of the energy spectrum of secondary electrons emitted from NaCl and KCl is determined for primary electron energies up to 50 eV. Two systems of maxima are found; the first is associated with the characteristic energy loss, but the nature of the second requires further investigation. The energy loss occurs at primary electron energies less than the width of the forbidden zon and below 12 eV is related to optical data. R.F.S.Hearmon

537.533

10942 **THE SECONDARY ELECTRON EMISSION OF TELLURIUM.** I.M.Bronshtein and R.B.Segal'.
Fiz. tverdogo Tela, Vol. 1, No. 7, 1133 (July, 1959). In Russian.

Reports dependence of the secondary electron emission coefficient σ on the primary electron energy E_p for $E_p = 0\text{-}2400$ eV. This curve has a maximum at $E_p = 400\text{-}500$ eV; $\sigma_{max} = 1.22$.
A.Tybulewicz

537.533 : 621.385.2

10943 ON THE THEORY OF THE CLOSE-SPACED IMPREGNATED CATHODE THERMIONIC CONVERTER.
E.S.Rittner.
J. appl. Phys., Vol. 31, No. 6, 1065-71 (June, 1960).

The tables associated with the exact Langmuir space-charge theory were represented to a maximum relative error of 0.01% by approximation formulae which are suitable for use with digital computers. Application of the exact theory to a thermionic converte comprising two close-spaced planar impregnated cathodes permitte a critical evaluation of the approximate space charge theory of Nottingham (Abstr. 7072 of 1959). The influence of the electrode separation, the emitter and collector work functions and of the emitter temperature was investigated. Spectral emittance measurements on a cathode surface at two wavelength resulted in a more firmly based estimate of the radiation heat transfer between two impregnated cathodes and of the maximum efficiency of an ideal design.

537.533 : 536.2 : 621.385.13.032.22

10944 THERMAL CALCULATIONS FOR ANODES OF ELECTRON TUBES COOLED BY RADIATION IN A VACUUM.

V.Ya.Frenkel'.

Zh. tekh. Fiz., Vol. 29, No. 11, 1400-6 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1290-5 (May, 1960).

Considers the design of plane anodes for vacuum electron tubes. Consideration is given to the radiation of heat from the inner surfaces of the anodes and the thermal shielding due to various structural elements. The formulae and curves which are obtained can be used to determine the dissipation power of an anode for a given geometry and temperature. The method can also be used for designing plane anodes other than those considered in the paper.

537.533 : 621.385.2

10945 TRANSPORT OF NOISE AT MICROWAVE FREQUENCIES THROUGH A SPACE-CHARGE-LIMITED DIODE.

W.E.Vivian.

J. appl. Phys., Vol. 31, No. 6, 957-62 (June, 1960).

Several analysis of the transport of cathode shot noise through a space-charge-limited diode at microwave frequencies have been published to date. Each of these analyses has been beset by inconsistencies arising from assumptions of monovelocity perturbation flow, direct or reflected. A new method of analysis of diode flow eliminating this problem has been developed. Numerical results based on this method are presented. Attention is restricted to the now classical problem of one-dimensional longitudinal confined flow. The magnitude and variation with distance of the so-called beam noise invariants is shown for a range of diode operating conditions. These calculated results, based for economy on an approximate static flow model, essentially substantiate the qualitive expectations suggested by prior analyses, and fit what little experimental data are available. The method of analysis employed in the calculation of the numerical results comprises a linear multistream formulation, based on representation or approximation of the perturbation particle density for the noise flow as a composite of singular impulse streams, N in number, along characteristic trajectories in the velocity-distance phase space. The set of N coupled first-order linear differential equations resulting is solved by simultaneous numerical extrapolation.

537.533 : 621.385.3

10946 A GENERAL RELATION AMONG THE PARAMETERS OF MULTI-ELECTRODE VALVES. B.Meltzer.

J. Electronics and Control, Vol. 7, No. 5, 416 (Nov., 1959).

Derives, for a space-charge-limited vacuum device, the relation:

$$R_a^{-1} V_a + g_1 V_1 + \dots + g_n V_n = (3/2) I_a$$

where the g's are the electrode transconductances, and R_a, I_a the anode resistance and current; applies the result to establish a limit on amplification factor possible in a triode. B.Meltzer

537.533 : 538.56 : 621.372.829

10947 ELECTRON BEAM IN A SPIRAL WAVEGUIDE (TAKING ACCOUNT OF THE GEOMETRIC DIMENSIONS OF THE SPIRAL). B.V.Kondrat'ev.

Zh. tekh. Fiz., Vol. 29, No. 12, 1477-80 (Dec., 1959). In Russian.

Spiral waveguides having hitherto been considered merely as anisotropically conducting sheets, the present work takes account of their periodic structure, which is found to sustain one backward and three forward waves. The electron beam is shown to interact chiefly with the forward waves. A.E.I.Research Laboratory

537.533 : 538.56 : 621.385.833

10948 OPTIMAL FOCUSING OF AN ELECTRON BEAM IN THE REGION OF TRANSIT THROUGH THE INPUT WAVEGUIDE OF A TRAVELLING-WAVE TUBE WITH A PERIODIC MAGNETIC FIELD. A.L.Igratskii.

Zh. tech. Fiz., Vol. 30, No. 4, 413-23 (April, 1960). In Russian.

A method of calculating the trajectories of electrons travelling through the input waveguide of a travelling-wave tube is worked out. A new method of minimizing the fluctuations in cross-section is given — this halves the minimum fluctuation found by earlier workers, but maintains the beam parallel as it enters the periodic focusing field. Methods of calculating the configuration of the magnetic field in the transit region and of designing the corresponding magnet are given. A.E.I.Research Laboratory

537.533

10949 AN IMPROVED ELECTROSTATIC ELECTRON SELECTOR. P.Marmet and L.Kerwin.

Canad. J. Phys., Vol. 38, No. 6, 787-96 (June, 1960).

A cylindrical electrostatic electron selector is described which provides a 10^{-7} ampere beam of electrons whose energy may be varied from 0 to 50 eV and whose energy spread is less than 100 mV. Space-charge problems involved in the construction of the device were overcome by the use of grids for focusing electrodes with exterior electron traps, and a non-reflecting surface for electrons made from a network of tiny tubes. The selector is provided with an energy analyser. When used to determine the appearance potential curve of argon, the selector resolved the $2P_{3/2}$ and $2P_{1/2}$ states separated by 0.18 eV, and indicated the formation of A_2^+ at an energy of 0.8 eV below the threshold for A^+.

537.533

10950 SMALL OSCILLATIONS OF AN ELECTRON BEAM. R.V.Polovin and N.L.Tsintsadze.

Zh. tekh. Fiz., Vol. 27, No. 7, 1466-73 (July, 1957). In Russian.

The behaviour of electron beams with uncompensated space charge toward small electromagnetic oscillations is investigated semi-qualitatively. It is found that such beams are stable with respect to transverse oscillations having a phase velocity greater than that of light, and also to longitudinal oscillations if the temperature of the electrons is small. In the latter case the nature of the waves depends on whether the beam density be small or great. A.E.I. Research Laboratory

537.533 : 537.54

DECOUPLING OF THE OSCILLATIONS ABOUT A CENTRAL TRAJECTORY IN AN ELECTROMAGNETIC FIELD. See Abstr. 9116

537.533 : 621.385.833

10951 THE INFLUENCE OF A MAGNETIC FIELD ON THE THERMAL SPREADING OF THE BEAM IN AN ELECTRON GUN. Yu.V.Troitskii.

Zh. tekh. Fiz., Vol. 30, No. 1, 25-30 (Jan., 1960). In Russian.

The cathode of an electron gun is partially shielded from the magnetic field which counteracts space-charge spreading in the post-anode region. It is shown that, if the residual magnetic field in the neighbourhood of the cathode is properly aligned and of adequate strength, it can also counteract the spreading due to initial thermal velocities. A.E.I.Research Laboratory

537.533

10952 USE OF SF_6^- FOR CALIBRATION OF THE ELECTRON ENERGY SCALE. G.J.Schulz.

J. appl. Phys., Vol. 31, No. 6, 1134 (June, 1960).

Under certain conditions the energy scale established with SF_6^- may be erroneous unless the potential along the path of the electron beam in the collision chamber is considered in detail. S.J.St-Lorant

537.533

10953 SIGNIFICANCE OF ELECTROMAGNETIC POTENTIALS IN THE QUANTUM THEORY IN THE INTERPRETATION OF ELECTRON INTERFEROMETER FRINGE OBSERVATIONS.

F.G.Werner and D.R.Brill.

Phys. Rev. Letters, Vol. 4, No. 7, 344-7 (April 1, 1960).

The effects of electromagnetic potentials in quantum theory have been considered in relation to the observation of fringes in electron interferometers operating in the presence of weak alternating magnetic fields. At first it was thought that, according to quantum theory, such fields would destroy the fringe pattern. Further, more exact analysis has now shown that this view was erroneous; there is in fact no contradiction between the experimental observations of the fringes and the predictions of quantum theory. A.E.I. Research Laboratory

537.533

10954 MOTION OF CHARGED PARTICLES IN A SPATIALLY-PERIODIC MAGNETIC FIELD.

K.D.Sinel'nikov, B.N.Rutkevich and V.D.Fedorchenko.

Zh. tekh. Fiz., Vol.30, No. 3, 249-55 (March, 1960). In Russian.

Equations of motion are set up and solved, for various initial conditions, for charged particles moving in the magnetic field:

$$\vec{H} = \vec{H}_0 + \vec{H}_\sim \cos\nu z.$$

Numerical relations are presented to show the dependence of the orbit parameters on the ratio $\omega_H/\nu v_0$, where ω_H is the Larmor frequency (eH/mc) and v_0 is the particle's initial projection velocity.

J.W.Gardner

537.533

10955 INVESTIGATION WITH MAGNETIC TRAP.

K.D.Sinel'nikov, V.D.Fedorchenko, B.N.Rutkevich, B.M.Chernȳi and B.G.Safronov.

Zh. tekh. Fiz., Vol. 30, No. 3, 256-60 (March,1960). In Russian.

The spatially-periodic field (described in preceding abstract) is employed as a magnetic "trap" for negative particles. Such particles, injected with appropriate velocities, will crowd into close stable orbits; the resulting space charge then behaves as a potential well for positive ions.

J.W.Gardner

537.533

10956 A STUDY OF MAGNETIC ELECTRON LENSES.

P.Durandeau.

Ann. Fac. Sci. Univ. Toulouse, Vol. 21, 1-88 (1957). In French.

A detailed study of the design and construction of magnetic electron lenses, being a doctoral thesis. The first part describes a method of accurately measuring the distribution of the magnetic field, already published (Abstr. 5562 of 1953). From these measurements the optimum shape and dimensions of the pole-pieces are derived, with special reference to the avoidance of saturation in the magnetic circuit. An attempt is made to fit the axial field distribution to an analytical expression. The electron optical characteristics (focal length, principal planes, chromatic and spherical aberration) are graphed in terms of a geometrical parameter

$$L = (S^2 + 0.45\ D^2)^{1/2}.$$

In two appendices, the measurement of the first derivative of the field and problems of hysteresis are discussed, respectively.

V.E.Cosslett

537.533

10957 CONTRIBUTION TO THE STUDY OF THE MAGNETIC FIELDS OF ELECTRON OPTICS.

P.Gautier.

Ann. Fac. Sci. Univ. Toulouse, Vol. 21, 89-184 (1957). In French.

This is a thesis, primarily concerned with the development of a direct-reading method of measuring the magnetic field on the axis of a magnetic electron lens and its first derivative by use of an oscillating coil. The first two chapters deal with the principles of the method and the construction of search coils. Chapter III gives the procedure in detail and Chapter IV discusses the experimental errors. The next chapter contains measurements on lenses of rotational symmetry, which are in good agreement with the results of others. Some preliminary work on lenses of cylindrical symmetry is also described, in particular the verification of an analytical expression for the field distribution. Two appendices discuss the use of other types of search coil, and the symmetry properties of fields, respectively.

V.E.Cosslett

537.533

10958 INVESTIGATION OF THE FOCUSING PROPERTIES OF A PARABOLOIDAL MAGNETIC LENS.

P.I.Strel'nikov and A.I.Fedorenko.

Zh. tekh. Fiz., Vol. 30, No. 2, 138-41 (Feb., 1960). In Russian.

It is shown that the space-charge spreading of an electron beam can be counteracted by placing immediately after the electron gun a magnetic lens of paraboloidal form. A current density of 0.8 A/mm^2 can be concentrated into a beam 1 mm across.

A.E.I. Research Laboratory

537.533

10959 VERTICAL FOCUSING OF A BEAM OF ELECTRONS BY CYLINDRICAL MAGNETIC LENSES IN AN AXIALLY SYMMETRICAL RADIALLY INCREASING MAGNETIC FIELD.

V.M.Kel'man, B.P.Peregud, K.A.Dolmatova and I.D.Luzyanin.

Zh. tekh. Fiz., Vol. 30, No. 2, 153-8 (Feb., 1960). In Russian.

A beam of electrons circling in a horizontal plane under the influence of a magnetic field normally loses intensity in successive turns due to vertical spreading. Cylindrical lenses periodically disposed around the path of the beam counteract spreading and markedly lessen the intensity fall-off. The performance of a system in which the lenses are formed by radial pairs of conductors is discussed in detail.

A.E.I. Research Laboratory

537.533

10960 MAGNETIC CYLINDRICAL LENSES WITH PLANE OF ANTISYMMETRY.

S.Ya.Yavor, E.V.Shpak and R.M.Minina.

Zh. tekh. Fiz., Vol. 30, No. 4, 395-404 (April, 1960). In Russian.

Magnetic cylindrical lenses, formed from current-carrying conductors so arranged as to produce a field with a plane of antisymmetry, provide focusing for particle accelerators. The field distribution and imaging properties of typical examples are calculated and measured.

A.E.I.Research Laboratory

537.533

10961 IMAGE DEFECTS OF CATHODE ELECTRON LENSES WITH VIOLATION OF AXIAL SYMMETRY OF THE FIELD.

Yu.V.Vorob'ev.

Zh. tekh. Fiz., Vol. 29, No. 5, 589-96 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 525-31 (Nov., 1959).

Expressions are obtained for the first- and second-order aberrations of an electrostatic immersion objective which accepts a wide pencil of electrons. The method due to Grinberg (Abstr. 8043 of 1958) is followed.

V.E.Cosslett

537.533

10962 THE EFFECT OF THE THICKNESS OF THE FOCUSING ELECTRODE ON THE OPTICAL PROPERTIES OF AN ELECTROSTATIC IMMERSION OBJECTIVE.

A.M.Rozenfel'd.

Zh. tekh. Fiz., Vol. 29, No. 5, 584-8 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 521-4 (Nov., 1959).

The investigation was aimed at finding the optimum design for an immersion lens for an emission electron microscope of highest possible resolving power. It was found that the focal length of the lens is not influenced by the thickness of the focusing electrode next to the cathode. But practical factors prevent the attainment of a focused image at a focal length smaller than three times the thickness of this electrode. For high resolving power the thickness cannot be less than 0.5 mm, and so the minimum focal length is 1.5 mm.

V.E.Cosslett

537.533

10963 METHOD OF SOLVING A CLASS OF AXIALLY SYMMETRIC PROBLEMS IN POTENTIAL THEORY. APPLICATION TO THE DESIGN OF ELECTRON-OPTICAL LENSES.

G.A.Grinberg and I.A.Shukeilo.

Zh. tekh. Fiz., Vol. 29, No. 11, 1293-303 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1189-98 (May, 1960).

Considers the solution of a class of problems which arise in the calculation of rotationally symmetric fields of electrostatic systems. It is established that if the systems satisfy certain geometrical conditions, the solutions can be reached by making a series of successive approximations, each of which is obtained by solving a plane electrostatic problem. Charge distribution on a ring and on two types of cylindrical lens are considered.

537.533

10964 A NEW ELECTRON MIRROR DESIGN.

J.D.Kuehler.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 202-4 (April, 1960).

A modification is described of the electron mirror designed by Mayer (Abstr. 405 of 1956) for investigating variations in electrostatic potential or magnetic field over a surface. The electron beam, instead of passing to and from the surface along the same path, is bent in a normal magnetic field so that an off-axis viewing screen well separated from the cathode can be used. It is not in fact a new design, being a "re-discovery" of the original mirror microscope of Bartz, Weissenberg and Wiskott (Proceedings of the International Electron Microscopy Conference, London, 1954, p. 395). A number of micrographs are reproduced of magnetic field distributions on recording tapes and on a nickel-cobalt evaporated film, at a maximu magnification of 295.

V.E.Cosslett

537.533 : 621.385.833

10965 EXPERIMENTAL ELECTRON MICROSCOPE HAVING A HIGH RESOLVING POWER.

A.Delong, V.Drahoš, J.Speciálný and L.Zobač.

Slaboproudy Obzor, Vol. 21, No. 4, 195-206 (1960). In Czech.

A fairly detailed description of the instrument is given (with drawings, diagrams and photographs). It is shown that the theoretical resolution of the microscope operating at accelerating voltages between 30 and 100 kV should be about 4 A. However, in practice the figure is higher due to axial astigmatism, chromatic aberration or the influence of external magnetic fields. The optimum practical resolution of 8 A is obtained at 80 kV with a magnification 120 000. The magnification range of the instrument is 2500 to 180 000. The optical system of the microscope consists of a double condenser lens, an objective, two intermediate lenses and the main projector lens. The accelerating potential is derived from a stabilized h.f., h.v. supply. Ripple and stability of this source are of the order of 10^{-5}. Currents to the lenses are derived from special stabilizers based on the principle of negative dynamic resistance. The ripple and the stability of these devices are about 10^{-4}-10^{-5}.

R.S.Sidorowicz

537.533 : 539.2 : 548.7

10966 A DOUBLE OBJECT CHAMBER FOR THE STUDY OF DOUBLE DIFFRACTION OF ELECTRONS BY TWO CRYSTAL LATTICES. O.Rang and J.Demny.

Exper. Tech. der Phys., Vol. 7, No. 5, 208-17 (1959). In German.

In connection with a theoretical investigation of diffraction patterns from superimposed lattices, an accessory has been made for studying them in controlled conditions in the electron microscope. It consists of two separately movable object stages, one above the other, in an electrostatic lens which was designed with electrodes convex upwards so as to leave free space for the stages. The lower stage can be traversed in two directions at right angles, tipped about one of these directions and rotated about the optical axis. In the upper stage the tipping action is replaced by an axial displacement, the other three motions being the same. Test experiments with colloidal gold crystals are described. Micrographs are shown of the same two crystals superimposed in two different azimuths and diffraction patterns from them in four different azimuths.

V.E.Cosslett

537.533

10967 A CONJUGATE METHOD OF PRE-ACCELERATION AND POST-ACCELERATION FOR THE STUDY OF ELECTRON SPECTRA OF VERY WEAK ENERGY. A.Juillard and M.A.Moussa.

J. Phys. Radium, Vol. 19, No. 1, 94-5 (Jan., 1958). In French.

Pre- and postaccelerations are used in a double focusing β spectrometer to study the 0 - 3 keV energy range. The method has been applied to the 7 keV conversion line of Co^{57} and the spectrum of disintegration products of Pb^{212}

537.533

10968 POSSIBILITY OF POLARIZATION OF FREE ELECTRONS. S.Yamaguchi.

Indian J. Phys., Vol. 32, No. 1, 45-7 (Jan., 1958).

Describes an experiment in which an electron beam was diffracted by a permanently magnetized powder, giving a splitting of the beam, which is explained by the author as due to interaction between the electron spins and the magnetic field gradient at the border between Weiss' magnetic domain and Bloch's magnetic wall.

J.Hawgood

537.533

10969 ENERGY LOSSES OF ELECTRONS PASSING THROUGH RARE GASES. I. S.Arai.

Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 2, 51-70 (Aug., 1958).

The energy losses of 20 keV electrons passing through rare gases He, Ne, A, Kr and Xe were measured by a modified version of an apparatus used for electron losses in foil (see Abstr. 5994-5 of 1959). The energy losses were measured at several angles of scattering ranging from 0 to 3.6×10^{-3} rad. They could be measured reproducibly within deviation ±0.02 eV or less under a suitable condition. The energy losses of electrons scattered at zero angle were in fair agreement with the optical terms calculated from the ground state of the neutral atom. The energy losses of electrons passing through He were compared with the excitation potentials measured by Franck and Knipping, and with the energy losses measured by McMillen. With increase of angle of scattering, the energy losses in the respective gases were found to increase slightly. The spectral intensity of the energy loss spectrum was also found to be dependent upon the angle of scattering. The energy loss spectrum of electrons passing through each rare gas showed a continuous spectrum ranging from ionization potential to about 100 eV, and the spectral intensity of the continuous spectrum was estimated quantitatively by photographic photometry.

537.533

10970 ENERGY LOSSES OF ELECTRONS PASSING THROUGH RARE GASES. II. S.Arai.

Sci. Rep. Tohoku Univ. First Ser., Vol. 42, No. 3, 123-9 (Oct., 1958).

As a continuation of previous work, energy loss spectra of 20 keV electrons passing through rare gases He, Ne, A, Kr and Xe were investigated mainly in the range of energy loss larger than the first ionization potential. Spectral lines of weak intensity corresponding to the duplication of energy loss caused by excitation of outer electrons were recognized for all rare gases. Continuous spectra of weak intensity corresponding to ionization of the inner electrons were found for several gases, but spectra corresponding to the second ionization potential were not found for all rare gases. The spectral intensity was estimated by photographic photometry.

537.533

10971 THE UNIVERSAL NATURE OF ELECTRON PENETRATION IN SOLIDS. A.F.Makhov.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1749-51 (Nov., 1959). In Russian.

The universal nature of electron transmission in solids within a very wide energy range was inferred from the fact that identical intensity curves $\eta_{E_0}(x)$, giving the relative number of electrons of a given initial energy E_0 which reach a depth $> x$, are obtained for various values of E_0, if a coordinate $\chi_n = x/x_n$ is employed instead of the usual coordinate x.

M.H.Sloboda

ION EMISSION . ION BEAMS

537.534

10972 NON-STATIONARY THERMIONIC EMISSION OF NICKEL AND TUNGSTEN IN VACUO.

E.I.Agishev and Yu.I.Belyakov.

Zh. tekh. Fiz., Vol. 30, No. 2, 223-5 (Feb., 1960). In Russian.

On sharply heating a mass of nickel in vacuo, bursts of ions having $m/e \sim 100$ are observed. These are reproducible after cooling and reheating, though temporarily inhibited by the admission of certain gases into the vacuum. Similar bursts are observed with a tungsten emitter. The nature of the ions has not been established; it is thought that they may come from organic radicals with low ionization potentials.

A.E.I. Research Laboratory

537.534

10973 POSITIVE COLUMN FORMATION IN ION SOURCES EMPLOYING SURFACE IONIZATION.

P.L.Auer and H.Hurwitz, Jr.

J. appl. Phys., Vol. 31, No. 6, 1007-9 (June, 1960).

A previous calculation (Abstr. 2393 of 1959) is used to discuss the unidimensional flow of positive ions in a tube where both ions and electrons issue from an emitter surface but only ion current is collected by means of an accelerating electrode. The resulting ion flow can be neutralized to varying degrees by the electrons present. It is found that even in the absence of collisional interactions the potential distribution in the tube may closely resemble the electrode sheath and positive column structure familiar to glow discharges. This is the situation to be expected whenever the ion current has values far in excess of that predicted from a zero degree of neutralization space charge limited theory.

537.534

10974 OBSERVATIONS OF BEAM PULSATIONS FROM H.F. ION SOURCES. T.Grjebine, R.Moreau and B.Olkowsky.

J. Phys. Radium, Vol. 19, No. 1, 108 (Jan., 1958). In French.

The beams of two electrostatic accelerators and a continuous voltage experimental design have shown pulsations of the same frequency as their h.f. ion source. In some conditions, the proportion of this alternating current was found to be 70%.

537.534

10975 A THERMAL ION SOURCE FOR LITHIUM. K.Habfast.

Z. Naturforsch., Vol. 15a, No. 3, 273-4 (March, 1960). In German.

Describes the construction and operating technique for a lithium ion source, which has a steady output and low fractionating properties. This is brought about by physically separating the ionizing system from the heating system. The heater current is kept constant to 0.1%. Memory effects are avoided by stringent cleaning procedures after each run. A.E.I. Research Laboratory

537.534

10976 THE MECHANISM OF SPACE-CHARGE OSCILLATIONS IN QUASI-COMPENSATED ION BEAMS. M.V.Nezlin.

Zh. tekh. Fiz., Vol. 30, No. 2, 168-77 (Feb., 1960). In Russian.

A beam of ions shot through rarefied gas in a strong magnetic field is space-charge-compensated by electrons produced when ions strike gas molecules. Oscillations set up in the process cause marked decompensation. Measurement of the current density and field distribution in the beam throws light on the mechanism of this. Basically, current density varies more widely than current strength and in places these go into antiphase. The consequences are discussed in detail. An experiment in which artificial oscillations are introduced into the system serves as a check.

A.E.I. Research Laboratory

537.534

10977 DIFFERENTIAL GEOMETRY OF THE TRAJECTORIES OF CHARGED PARTICLES. H.Figueras.

C.R. Acad. Sci. (Paris), Vol. 250, No. 12, 2143-5 (March 21, 1960). In French.

Using a moving frame of reference, studies the trajectories of charged particles in an electromagnetic field. T.R.Carson

537.534

10978 OPTICAL PROPERTIES OF AXIALLY SYMMETRICAL MAGNETIC FIELDS WITH A CENTRAL SOURCE OF CHARGED PARTICLES. S.A.Kuchai.

Zh. tekh. Fiz., Vol. 30, No. 2, 142-52 (Feb., 1960). In Russian.

Particles emitted from a source in an axially symmetric magnetic field under proper conditions take up stable orbits. Particular attention to the mathematics is required to predict the behaviour of particles coming from a line source on the axis. Their equations of motion are developed and aberrations discussed. Application to isotope separation is considered, certain favourable types of field being specified. A.E.I. Research Laboratory

537.534 : 537.1.07

10979 THE DETERMINATION OF A TANGENT TO THE TRAJECTORY OF A CHARGED PARTICLE.

M.Huybrechts.

Bull Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 8, 777-81 (1959). In French.

If a tangent is drawn to a point in the trajectory of a charged particle travelling in a medium in which it leaves a visible trace, a method of minimum deviation is given for the determination of the angle between the tangent and the trace. It is supposed that the particle undergoes multiple scattering and that the variance on the angle between the initial and final tangents is known and also the variance (δ^2) on the coordinates of the trace due to grain density and measurement. The angle so calculated is compared with that obtained from the method of least squares in the specific instance when $\delta^2 = 0$.

A.E.I. Research Laboratory

537.534

10980 MOTION OF PARTICLES IN A TOROIDAL CORRUGATED MAGNETIC FIELD. A.I.Morozov and L.S.Solov'ev.

Zh. tekh. Fiz., Vol. 30, No. 3, 261-70 (March, 1960). In Russian.

A magnetic trap for confining moving particles into a specified region is formed by disposing a corrugated magnetic field around a toroid (stellarator). It is shown that for sufficiently large radius of the toroid the trap can become absolute by the establishment of a magnetic surface which no particles, whatever their direction of motion, can penetrate. A.E.I. Research Laboratory

537.534

10981 MOTION OF PARTICLES IN A SCREW-FORM TOROIDAL MAGNETIC FIELD. A.I.Morozov and L.S.Solov'ev.

Zh. tekh. Fiz., Vol. 30, No. 3, 271-82 (March, 1960). In Russian.

A magnetic trap designed to restrict particles to a specified region is formed by a magnetic field in the form of a screw wound round a toroid. Equations of motion for the particles are derived and their behaviour discussed. Motion in a figure-of-eight system is also considered. A.E.I.Research Laboratory

537.534 : 537.56

10982 MOTION OF A RELATIVISTIC CHARGED PARTICLE IN THE MAGNETIC FIELD PRODUCED BY A CONSTANT CYLINDRICAL [DISCHARGE] CURRENT OF A RAREFIED PLASMA.

N.I.Shtepa.

Zh. tekh. Fiz., Vol. 29, No. 11, 1346-53 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1237-43 (May, 1960).

It is assumed that the current density is uniform. Quadrature relations are obtained which determine the radial dimensions of the region of allowable motion, the period of the radial oscillations, the period of rotation about the axis of symmetry, and the mean drift velocity of the particles in the axial direction.

537.534

10983 ACHROMATIC MAGNETIC MIRRORS.

V.M.Kel'man, S.Ya.Yavor and T.Ya.Fishkova.

Zh. tekh. Fiz., Vol. 30, No. 2, 129-37 (Feb., 1960). In Russian.

Magnetic fields of plane symmetry act as achromatic mirrors for beams of charged particles, provided that the angle of inclination is related in a specified way to the field distribution. Examples of this are worked out and the range of validity of earlier approximate formulae is given. A.E.I. Research Laboratory

537.534

10984 OPTICS OF THE DEFLECTION OF A BEAM OF HIGH ENERGY CHARGED PARTICLES. II. J.Pinel.

Ann. Radioelect., Vol. 15, 3-27 (Jan., 1960). In French.

The principles outlined in Pt I (see Abstr. 12382 of 1959) are applied to a particular case. An examination is made of defects due to optical elements, of which field structure defects are the most important. Debunchers are dealt with and some essential properties of systems using two electromagnets with parallel faces are given. Several solutions to the problem of triple focusing are given and defects of these various systems are examined. One optical system was tested using a hodoscope. The conditions of application of the method and its possibilities are examined. One application is the adjustment, measurement of resolving power, aberrations, and mixed focusing of the 250 MeV beam in the Orsay linear accelerator.

537.534

10985 NUMERICAL CALCULATION OF THE POTENTIAL DISTRIBUTION IN ION SLIT LENS SYSTEMS. II.

A.J.H.Boerboom.

Z.Naturforsch., Vol. 15a, No. 3, 244-52 (March, 1960).

For Pt I, see Abstr. 280 of 1960. The potential distribution is computed in certain ion slit lens systems, consisting of three parallel slits in three parallel electrodes. In Pt I, the case was treated where the slit widths were smaller than the distances to the neighbouring electrodes. In the present paper, this requirement is relaxed; for the sake of simplicity, however, the computations are confined to the case where the central electrode represents a plane of symmetry. Various approximation and iteration methods are given to find the necessary parameters to perform the Schwarz-Christoffel transformation. Several typical examples are given.

537.534

10986 THE POTENTIAL DISTRIBUTION IN A TOROIDAL CONDENSER. A.J.H.Boerboom.

Z. Naturforsch., Vol. 15a, No. 4, 347-50 (April, 1960).

The electrostatic potential is calculated in a toroidal condenser consisting of two rotational symmetric electrodes having the media plane as a plane of symmetry. The result is expressed as a series expansion in the coordinates around the main circle and in the mutual distance of the electrodes in the median plane.

537.534 : 621.316.72

10987 TRANSISTORIZED POWER SUPPLIES FOR A MASS SPECTROMETER. R.D.Russell and F.Kollar.

Canad. J. Phys., Vol. 38, No. 5, 616-23 (May, 1960).

While a mass spectrometer itself may require a few hundred watts of regulated power for the magnet and only a few watts of reg lated power for all other purposes, the regulating supplies ofter dis pate kilowatts. The construction of more efficient supplies using transistors and magnetic amplifiers results in substantial savings in the physical size of the supplies, the cost of their component par and the effort required for maintenance. Circuits and descriptions are presented for a magnet current power supply and a filament emission control that have been used in a recently built mass spectrometer. These illustrate the simplicity possible with ransistor-regulated supplies, as well as the savings mentioned bove. The mass spectrometer is a 12-in. radius 90° instrument sed at mass 250 with a 5000 V accelerating voltage. The magnet, hich supplies a field of more than 5000 G over an area of 800 cm^2 nd across a gap of 1.9 cm, and which weighs three quarters of a ton, s supplied from a regulated supply dissipating about 50 W. The ilament emission control takes about 30 W from the mains.

537.534

10988 THE OXIDATION OF NICKEL BY IONIC BOMBARDMENT. J.J.Trillat, L.Tertian and N.Terao.
ahiers de Phys., Vol. 12, 162-3 (April, 1958). In French.

An oriented Ni film (approx. 200 A) on a NaCl substrate was ombarded with 10 kV ions from air. The formation of NiO was stablished by surface reflection electron diffraction experiments.
J.E.Caffyn

537.534

10989 SPUTTERING OF SILVER BY LIGHT IONS WITH ENERGIES FROM 2 TO 12 keV.
.Grønlund and W.J.Moore.
. chem. Phys., Vol. 32, No. 5, 1540-5 (May, 1960).

Electromagnetically analysed ionic beams from a radiofrequency ource were used to study the sputtering yield S (atoms per ion) for ight ions normally incident on silver targets at energies from 2 to 2 keV. The yields displayed broad maxima with energy in the range tudied. At 5 keV the following values of S were found: H^+, 0.035; $^+$, 0.090; H_2^+, 0.077; D_2^+, 0.21; H_3^+, 0.11; D_3^+, 0.33; He^+, 0.48; $^+$, 4.0; O^+, 4.4; Ne^+, 5.5. The angular distribution of sputtered ilver followed a cosine dependence about the normal to the target urface even when the beam hit the target at oblique incidence.

537.534

10990 DIRECTED EMISSION OF PARTICLES FROM A COPPER SINGLE CRYSTAL SPUTTERED BY OMBARDMENT WITH IONS UP TO 50 keV ENERGY.
.E.Yurasova, N.V.Pleshivtsev and I.V.Orfanov.
h. eksper. teor. Fiz., Vol. 37, No. 4(10), 966-72 (Oct., 1959). n Russian. English translation in: Soviet Physics—JETP (New ork), Vol. 37(10), No. 4, 689-93 (April, 1960).

Sputtering of the (100) plane of a copper single crystal was tudied for various values of the energy and angles of incidence of rgon and hydrogen ions. It is shown that the particles of the puttered matter retain a favoured direction of emission along some rystallographic directions ([100], [110] etc.) when the energy of the ombarding ions is raised up to 50 keV. Thus a precipitate in the orm of separate spots is formed on a screen arranged parallel to he (100) face of Cu. With increase of the ion energy the pattern of he precipitate changes but is practically independent of the angle of ncidence of the particles. The distribution law of the densities of he spots corresponding to the [110] and [100] directions was studied. he matter in the spots is distributed according to a cosine law. he relief of the (100) Cu plane produced by sputtering by A^+ and $_2^+$ ions with energies up to 50 keV was also studied. The data obained cannot be explained by existing theory of cathode sputtering.

PARTICLE ACCELERATORS

537.54

10991 THE ELUTRON, A LINEAR-CYCLIC ACCELERATOR. D.M.Zorin, O.S.Milovanov and A.V.Shalnov.
. nuclear Energy, Vol. 7, No. 3-4, 264-5 (Sept., 1958). English anslation of article in: Atomnaya Energiya, Vol. 2, 552 (1957).

An accelerator is proposed which consists basically of two near accelerators and a system of magnetic mirrors which deflect he beam from one accelerator to pass through the other. A unit injects elativistic electrons into the accelerator which then make multiple asses through the machine in stationary orbits distributed about e axes of the linear accelerators. Theoretical investigations indiate that phase oscillations are similar to the microtron.
J.W.Sturgess

537.54 : 539.12

ACCELERATION OF POLARISED PROTONS WITH STRONG-OCUSING LINEAR ACCELERATORS. See Abstr. 9363

537.54

10992 THEORY OF INJECTION IN HIGH-CURRENT ORBITAL ACCELERATORS. A.N.Lebedev.
Zh. tekh. Fiz., Vol. 29, No. 11, 1339-45 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1231-6 (May, 1960).

The kinetic equation is used to analyse the injection conditions in a ring f.m. cyclotron in which high currents are used. In this case, the collective interaction of the particles is important. The relation between the collective capture coefficient and the injection current is determined.

537.54

10993 USE OF THE STRONG-FOCUSING PRINCIPLE FOR THE SHAPING OF ELECTRIC DEFLECTORS.
V.V.Krotov.
Zh. tekh. Fiz., Vol. 29, No. 6, 716-25 (June, 1959). In Russian. English translation in Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 643-50 (Dec., 1959).

The defocusing effect of the fringing magnetic field of a cyclotron may be counteracted by suitable shaping of the electric deflector responsible for extracting the beam. Balancing of the focusing and defocusing effects can be improved by splitting the extractor into two parts. This in effect provides a chain of three strong-focusing lenses and allows greater concentration of the beam.
A.E.I.Research Laboratory

537.54

10994 DESIGN OF A REGENERATIVE DEFLECTOR. Yu.Ya.Lembra.
Zh. tekh. Fiz., Vol. 29, No. 8, 992-4 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 901-3 (Feb., 1960).

A method is given for direct calculation of a deflector with one regenerator for accelerators with a periodic magnetic system. Two cases are considered: one in which the deflector acts on each turn and the other in which it acts on alternate passages. J.W.Sturgess

537.54

10995 DESIGN OF A STRONG-FOCUSING ACCELERATOR WITH FIXED MAGNETIC FIELD. V.K.Grishin.
Zh. tekh. Fiz., Vol. 29, No. 9, 1065-7 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 973-5 (March, 1960).

Methods are described for calculating the equilibrium orbit and betatron oscillations in a cyclic accelerator. J.W.Sturgess

537.54

10996 INFLUENCE OF THE QUANTUM CHARACTER OF RADIATION ON RADIAL-PHASE OSCILLATIONS IN ELECTRON CYCLIC ACCELERATORS AT HIGH ENERGIES.
A.N.Didenko.
Zh. tekh. Fiz., Vol. 27, No. 7, 1624-7 (July, 1957). In Russian.

A theoretical examination is made of the limiting conditions of radial and phase oscillations in a weak-focusing electron synchrotron, arising from the statistical fluctuation of emission of quanta of radiation by the accelerated electrons. The paper extends the work of a number of previous authors, including Sands (Abstr. 2784 of 1955). An equation relating energy to the synchrotron parameters is derived and by inserting reasonable numerical values it is concluded that 10 GeV is near the limit for weak-focusing synchrotrons.
J.H.Fremlin

537.54

10997 EFFECT OF INTERACTION ON THE PHASE MOTION OF ELECTRONS IN A SYNCHROTRON. L.V.Iogansen.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 299-300 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 211-12 (Jan., 1960).

An approximate calculation is made of the effects of electromagnetic interaction forces between the electrons, in a bunch of about 10^{14} particles, on the phase motion of the electrons. The equilibrium angular dimensions of the bunch are also estimated. Screening of electron interaction by the walls of the chamber and by the magnet is ignored. The approximation is only valid for small bunches.
J.W.Sturgess

537.54

10998 STEERING—FOCUSING SYSTEM FOR PARTICLE INJECTION IN A PROTON SYNCHROTRON.
A.A.Kolomenskii, A.B.Kuznetsov and N.B.Rubin.

Zh. tekh. Fiz., Vol. 29, No. 8, 981-91 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 892-900 (Feb., 1960).

The injection requirements for the 10 BeV proton synchrotron at the Joint Institute for Nuclear Research are given, together with the output characteristics of the linear accelerator used as the injector. The general optical properties of the system are derived. Four systems are considered. First, two versions of a steering—focusing magnet with fringe and gradient focusing. Second, two versions of a magnet followed by a short cylindrical condenser. The characteristics of the systems are given in tabular form. Limits are given for the tolerances on perturbations of the various system parameters. J.W.Sturgess

537.54

10999 MODIFICATION OF THE TIME STRUCTURE OF THE SYNCHROCYCLOTRON BEAM.

A.Cabrespine.

C. R. Acad. Sci. (Paris), Vol. 250, No. 14, 2544-6 (April 4, 1960). In French.

The conditions of using the external beam of a synchrocyclotron for nuclear physics experiments can be considerably improved by increasing the number of bursts of particles in each cycle. This is achieved on the Orsay machine by modifying the trajectories of the particles towards the end of the acceleration cycle using an auxiliary r.f. oscillator and accelerating electrode. J.D.Dowell

537.54

11000 INVESTIGATION OF ELECTRON-CAPTURE PROCESSES IN THE BETATRON.

Yu.S.Korobochko.

Zh. tekh. Fiz., Vol. 27, No. 7, 1603-5 (July, 1957). In Russian.

The mean circulating current in a 15 MeV betatron was compared with the injection current. Hence the mean number of electron revolutions occurring during capture of electrons in the injection pulse was found, together with the useful injection time. This might vary from 2-3 to 4-5, averaging 3-4 in the working range of the betatron. The efficiency of capture at various stages of the injection pulse was investigated. J.H.Fremlin

537.54

11001 AN INVESTIGATION OF THE RELATIVE EFFECTIVENESS OF TRAPPING ELECTRONS IN A BETATRON FOR DIFFERENT PARTS OF THE INJECTION IMPULSE.

A.P.Komar, Yu.S.Korobochko and V.T.Shchebolev.

Zh. tekh. Fiz., Vol. 29, No. 7, 852-5 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 770-2 (Jan., 1960).

Experiments are described on the mechanism of trapping electrons by measuring the relative efficiency of capture for any part of the injection pulse and for any current amplitude. With small injection currents, the capture takes place chiefly at the beginning of the pulse, whereas for larger currents trapping occurs mainly at the end of the pulse. J.W.Sturgess

537.54

11002 TWO PROCESSES CONTRIBUTING TO THE TRAPPING OF ELECTRONS IN THE BETATRON ACCELERATION RANGE.

A.P.Komar and Yu.S.Korobochko.

Zh. tekh. Fiz., Vol. 29, No. 7, 856-61 (July, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 7, 773-7 (Jan., 1960).

The processes are: 1) a resonant process causing a monotonic variation in the amplitude of radial oscillations of electrons from the injector; 2) an irregular change in amplitude of the radial oscillations caused by fluctuations of the electron current loops. The magnitude of the change in amplitude of the radial oscillations during a half period is estimated for the first process. The time needed for the second mechanism alone to produce the same change in the same amplitude is calculated. J.W.Sturgess

537.54

11003 INVESTIGATION OF ELECTRON CAPTURE IN A BETATRON WITH A FIXED GAP FIELD.

D.P.Ivanov, A.P.Komar and Yu.S.Korobochko.

Zh. tekh. Fiz., Vol. 29, No. 8, 975-7 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 886-8 (Feb., 1960).

The capture of electrons in a betatron with non-time-varying fields was established experimentally. The captured electrons could be detected by deflection on to a target at times up to 900 μsec after their capture corresponding to track lengths of up to 100 km. Observations indicate that the non-uniformity of the magnetic field does not lead to loss of electrons during circulation. Thus a time dependent increase of magnetic field in the gap does not affect the capture process noticeably. The ratio of the captured charge to the injected charge per cycle is about 2×10^{-4} J.W.Sturgess

537.54

11004 METHOD OF MEASURING THE TOTAL CHARGE OF ACCELERATED ELECTRONS IN A BETATRON.

D.P.Ivanov, A.P.Komar and Yu.S.Korobochko.

Zh. tekh. Fiz., Vol. 29, No. 8, 978-80 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 889-91 (Feb., 1960).

The method used with a betatron with maximum γ-energy of 15 MeV can determine only the lower limit for the charge. This was found to be 1.6×10^{-10} C corresponding to an orbit current of 60 mA. The γ-ray intensity was 4 r/min at a distance of 1 m from the 1mm thick tungsten target. To determine the charge exactly requires a lower maximum electron energy and a thicker chamber wall. J.W.Sturgess

537.54

11005 THE OPERATION OF A BETATRON WITH ELECTRON INJECTION PULSES OF SHORT DURATION.

O.S.Kolotov, Yu.N.Lobanov and N.I.Tulinova.

Zh. tekh. Fiz., Vol. 29, No. 9, 1173-4 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 1072-3 (March, 1960).

The behaviour of a betatron, when the injection consists of a pulse shorter in time than the period of revolution of the electrons in their orbit, was examined experimentally. It is concluded that the interactions between electrons having made different numbers of revolutions in the machine do not play an important part in the trappin mechanism. S.J.Goldsack

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

538 : 621.318.132

11006 STUDIES IN PARTIAL SWITCHING OF FERRITE CORES

R.H.Tancrell and R.E.McMahon.

J. appl. Phys., Vol. 31, No. 5, 762-71 (May, 1960).

The characteristics of Mg—Mn ferrite cores in a partially switched state are investigated. Questions are considered relating to the percentage of flux switched at various locations within a core as well as the speed of this switching. Results show that the amplitude and duration of the set pulse has a pronounced effect on the cor behaviour. It has been found that most of the variation of the switching waveform among different regions is due to the geometry of the core. Models are proposed to describe the behaviour observe experimentally. The operation of partially switched cores in a fast memory and the investigation of various memory schemes are discussed. Possible applications of the partially switched cores for digital computer applications are mentioned.

538

11007 MICROCALORIMETRIC TECHNIQUE FOR THE STUDY OF DAMPING AND HYSTERESIS IN FERROMAGNETIC FILMS.

J.R.Mayfield.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 298S-299S (May, 1960).

Experience with experimental techniques for the study of damping and hysteresis in thin films has suggested that many of the difficulties and complications encountered might be avoided by the direct approach of measuring the heat generated by the irreversible processes which are of interest. This suggestion has led to the development of a simple and reliable microcalorimetric apparatus wit which accurate loss determinations may be made over a frequency range of about 100 c/s to 100 Mc/s. The loss detector employed is a thin-film thermocouple which develops an e.m.f. proportional to the total heat flux emerging from the ferromagnetic sample. The zero drift of the heat-detecting system is eliminated, and the overal noise level greatly reduced by imposing a low-frequency square-wa modulation on the magnetic losses amplifying the resultant a.c. component of the thermal e.m.f with a narrow-band amplifier, and recti ying the output by means of a commutator phase-synchronized with he modulator. It appears that losses as small as 10^6erg.sec.$^{-1}$ cm^{-3} f sample volume are readily detectable. The thermal method hus has a degree of sensitivity which compares favourably with that f other experimental techniques, and has the added advantage of proiding a direct measure of energy loss.

538 : 621.395.625.3

11008 TRANSFER FUNCTION AND ERROR PROBABILITY OF A DIGITAL MAGNETIC TAPE RECORDING SYSTEM.

.W.Hung.

. appl. Phys., Suppl. to Vol. 31, No. 5, 396S-397S (May, 1960).

In spite of the complexities of the digital magnetic recording ystem, it has been discovered that the output of the system for the nput of a unit step of current can be approximated by a Gaussian robability function $A \exp[-a[x-d]^2$, were a is the figure-of-merit f the system. This yields an analytic expression for the transfer unction of the system. Experimental results correlate quite well ith those based on this approximate transfer function. Using this ransfer function, the output of the system for any "Nonreturn to ero" recording method can be predicted. For example, the reducion in system output with increasing bit densities is established. n addition, when Gaussian noise is introduced into the system, the rror probability is obtained. The effect of the input rise time to the utput amplitude is discussed.

538

11009 RICTOMETER SYSTEM FOR CALIBRATING TRANSMITTERS OF REMOTE INDICATING COMPASSES.

.I.Mendelsohn.

. appl. Phys., Suppl. to Vol. 31, No. 5, 183S-184S (May, 1960).

Calibration of the sensor (transmitter), of a remote indicating ompass system, must be carried out in a magnetic field whose magniude and direction simulate closely those of the earth at a specified oint. Major disturbances of the earth's magnetic field by electrical quipment occur in most laboratories. Where conventional elmholtz calibrating schemes are used, accuracy can be achieved nly by lengthy averaging of repeated measurements and excercising xtreme care. This paper describes a measurement system called rictometer, which permits precise transmitter calibration with uch greater ease than previously. The rictometer consists of a ystem of shields which reduces the earth's horizontal field compoent from 200 to ~0.3 mG. Two pairs of Helmholtz coils within e shielding system restore the horizontal component of the earth's eld. By proper selection of currents in each of these pairs of coils, his horizontal component can be rotated in discrete steps through 60° for calibration purposes. The rictometer allows the experienter to calibrate a compass transmitter readily with a precision f plus or minus 0.1 deg in normal laboratory fields. Deliberate mmersion of the rictometer in a 50 G field causes a maximum ransmitter calibration change of ±0.15°. Thus, the system should rove valuable for reliable sensor calibration under most adverse eld conditions.

538 : 534.8 : 621.317.44

11010 MAGNETIC FIELD MEASUREMENT USING ULTRASONICS. R.J.Radus.

. appl. Phys., Suppl. to Vol. 31, No. 5, 186S-187S (May, 1960).

The detection and measurement of magnetic field intensity for urposes of field plotting and uniformity studies is a most important onsideration in the field of magnetics. Field plotting and uniformity tudies have been conducted on certain sizes of magnetic geometries ith rotating coil instruments and Hall generators and quartz crystal agnetometer. The obvious limit of such devices is their minimum esolving power which can be defined in terms of sampling area nd minimum air gap. For the rotating coil instruments, the miniaum air gap is $\frac{1}{4}$ in. and the sampling area is roughly 1.2×10^{-2} in^2. ommercially available Hall generators which can be fitted into ir gaps of approximately 0.011 in. have sampling areas in the order f 3.2×10^{-3} in^2. Hall generators with sampling areas in the order f 10^{-7} in^2. have been reported in the literature. Minimum thickess of this type device is presumably less than 0.01 in. The more ecent work (see Abstr. 5125 of 1958) with the vibrating quartz rystal magnetometer has been used to measure flux density normal the surface of permanent magnets. The sampling area of this ype of equipment is 0.56×10^{-6} in^2. The minimun thickness of his equipment has not yet been reported in the literature. The lux-measuring equipment being described in this paper has a ampling area of approximately 6.25×10^{-6} in^2. and a sensitivity of pproximately 0.01×10^{-3} V/gauss. The probe consists of a single turn inductor of length $\frac{1}{16}$ in. which vibrates ±0.000,05 in. The inductor is fastened to a probe of 0.01 in. thickness and the 0.0001 in. motion is perpendicular to this 0.01 in. probe thickness. The physical geometry and size of this probe permits measurements in a variety of positions relative to the magnetic circuit. This type of probe is applicable for measuring flux density in air gaps as small as 0.017 in. The driving device for this equipment is a 60 kc/s magnetostrictive transducer. The complete probe consists of the transducer reactor, a coupling bar of nonmagnetic stainless steel and the thin strip of the nonmagnetic stainless steel to which the inductor is fastened. The geometry and size of this thin strip can be changed to accommodate variations in both inductor length and displacement.

538 : 621.317.44

11011 SIMPLE RECORDING TORQUE MAGNETOMETER.

P.W.Neurath.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 184S-185S (May, 1960).

A recording torque magnetometer has been designed and constructed, using commerically available components in conjunction with commonly available laboratory equipment. It appears to be much simpler than any described heretofore and needs no calibration. The sample disk is mounted at the end of a shaft which is supported in two fixed radial nonmagnetic precision ball bearings of low starting torque. The other end of the shaft carries a 10 cm long lever arm which exerts a force on a Statham Instruments, Inc., 0.3 oz transducer (Model G7A). The relative rotation of sample to magnet is converted to an electrical signal of any convenient magnitude by use of a 360° continuous rotation Helipot potentiometer. Both torque and rotation signals are recorded on an XY mV recorder. The electrical circuits consist only of batteries and resistors and the factory supplied transducer calibration is entirely adequate. The assembly can be rotated manually. At $\pm 40 \times 10^3$ ergs full scale, corresponding to an output of ±5 mV, errors are about 1%. Slight alterations in the design to cover full scale ranges from 10^4 to 10^5 ergs or more are possible.

538.1

11012 STABILIZATION OF A MAGNETIC FIELD BY MEANS OF A GALVANOMETER AND PHOTOCELLS. R.Stefant

C.R.Acad. Sci. (Paris), Vol. 250, No. 8, 1453-5 (Feb. 22, 1960). In French.

538.1 : 621.317.44

11013 EXPERIMENTAL FLUX PATTERN DETERMINATION IN MAGNETIC CORES. R.L.Ward.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 192S-193S (May, 1960).

The difficulties in determining the quiescent flux patterns in nonlinear magnetic structures is considered and two techniques are briefly described for measuring these patterns in magnetic cores etched from sub-mil thicknesses of 4-79 molybdenum Permalloy. Both methods utilize a sensing loop formed by moveable surface probes and a part of the core itself, which conductively completes the sense circuit. A detailed description of the measuring apparatus and the testing technique is given, and the graphical procedure for plotting the flux configuration of a two-aperture multi-path core is outlined. Finally, additional applications are enumerated.

538.1 : 621.317.44

11014 METHOD FOR MEASURING IRON LOSSES IN ELLIPTICALLY POLARIZED MAGNETIC FIELDS.

F.J.Young and H.L.Schenk.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 194S-195S (May, 1960).

A method for measuring iron losses in elliptically polarized magnetic fields has been devised. The fields are produced in a laminated one-inch cubic specimen by the superposition of two mutually perpendicular magnetic fields whose magnitudes and time phase angles can be varied. Orthogonal fields are obtained by the use of two "C" cores with air gaps large enough to contain the specimen. The flux density is ascertained from the voltages induced in two coils wound on the specimen with axes parallel to the two field components. The iron loss is determined by measuring the heating transient in the specimen. In addition, the anisotropy in losses due to alternating magnetic fields can be determined as a special case of elliptically polarized field excitation. The loss data obtained by this method agree with the results given by the standard Epstein test to within 15%.

538.1 : 537.2

MODELLING METHODS FOR MAGNETIC FIELDS. See Abstr. 10863

538.2 : 539.2

NEW MATERIAL FOR PERMANENT MAGNETS FOR A BASE OF Mn AND Al. See Abstr. 10135

538.2 : 621.317.39

11015 **INSTRUMENTATION APPLICATIONS OF INVERSE-WIEDEMANN EFFECT.** J.A.Granath.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 178S-180S (May, 1960).

The principle of the magnetostrictive rod and coil assembly which provides an a.c. voltage output at fundamental excitation frequency, with amplitude proportional to applied torque and phase-reversible with torque direction, is reviewed. The literature on applications of torsional magnetostriction and inverse-Wiedemann effect is limited and widely scattered. A brief summary of some of the literature on instrumentation applications for measurement of torque, force, and other physical quantities is presented. Examples include measurement of torque in rotating shafts, dynamometers, accelerometers, flowmeters, and force balance sensors. For use as a guide in transducer design, a simplified mathematical representation of the torque-signal relationship for one mode of operation is developed from the equations of mechanical strain and applied magnetic field energy. Shape of the torque-signal curve is linear in the vicinity of zero torque, curving off to asymptotes at the extremes. Means for extending the results of tests on standard samples to design guides on rod diameter, coil turns, and excitation frequency are suggested.

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

538.3

11016 **CLASSICAL ELECTRODYNAMIC EQUATIONS OF MOTION WITH RADIATIVE REACTION.** G.N.Plass.
Phys. Rev. Letters, Vol. 4, No. 5, 248-9 (March 1, 1960).

A discussion is given of the conditions under which the classical relativistic equations of motion of a charged particle including radiative reaction have physically meaningful (non-divergent) solutions. These conditions can be stated quite generally for the case of a purely time-dependent force, while examples of possible solutions covering most force fields of physical interest, are given for the case of space-dependent forces. R.F.Peierls

538.3

11017 **THE RADIATION REACTIONS IN THE MOTION OF A CHARGE IN A MEDIUM.** V.L.Ginzburg and V.Ya.Éidman.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1823-33 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1300-7 (Dec., 1959).

The radiation reaction force is computed for a charge that moves in a medium which, for generality, is taken to be anisotropic and gyrotropic. The radiation force in the medium can be important in cases in which the particle moves in a magneto-active plasma, in channels and slits in dielectrics, or in waveguides. At velocities greater than the phase velocity of light in the medium, the radiation force that affects the oscillation because of the anomalous Doppler effect has a different sign that that due to dissipation associated with the normal Doppler effect. The total radiation force which affects the amplitude of the oscillations of the particle in an isotropic medium corresponds to dissipation for motion at velocities greater than the velocity of light. However, this dissipation force may be appreciably smaller than the dissipation associated with motion at velocities smaller than the velocity of light. In an isotropic medium the oscillations can be strengthened instead of attenuated. The reduction in the radiative dissipation force may be related to the peculiarities of the anomalous Doppler effect as found in the quantum-mechanical analysis and the instability of particle beams which move at velocities greater than the velocity of light.

538.3

11018 **TRANSITION RADIATION AND CHERENKOV RADIATION.** V.E.Pafomov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1853-8 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1321-4 (Dec., 1959).

The angular distribution of the radiation produced by a charged particle which passes through the interface between a vacuum and an isotropic ferrite is considered; the case of a vacuum and a crystalline dielectric is also considered. It is shown that the radiation depends on the sign of the group velocity. The transition radiation is considered in connection with the characteristics of Cherenko radiation in crystals and in isotropic media in the frequency region characterized by negative group velocities. The "inverse" Doppler effect is considered.

538.3

11019 **TRANSITION RADIATION IN WAVEGUIDES.** K.A.Barsukov.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1106-9 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 787-9 (April, 1960).

Examines the radiation produced in a waveguide when a charged particle passes through the boundary between two media. It is shown that at ultrarelativistic charge velocities, the radiation is mainly in the forward direction and its magnitude is proportional to the particle energy. Formulae are derived for the radiation and for its spectral distribution.

538.3

11020 **THE SCATTERING OF ELECTROMAGNETIC WAVES ON FREE ELECTRONS IN A STRONG MAGNETIC FIELD.** L.É.Gurevich and S.T.Pavlov.
Zh. tekh. Fiz., Vol. 30, No. 1, 41-3 (Jan., 1960). In Russian.

Classical scattering theory gives only a coherent component. Quantum theory adds incoherent scattering. Expressions for total scattering are given, in particular for the limiting cases of long and short waves. It is shown that the degree of coherence depends on the angle of observation. A.E.I. Research Laboratory

538.3

11021 **THE MOTION OF A CHARGED PARTICLE IN A ROTATING MAGNETIC FIELD.** A.P.Kazantsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1463-4 (Nov., 1959). In Russian.

A mathematical note relating to the question of localizing a charged particle by sending it through a rotating magnetic field. This is a point of interest in plasma physics. Using a matrix method the motion in such a field is shown to be stable only in two pairs of narrow wedge-shaped regions, tapering towards the middle of the field but not reaching it. This occurs when the roots of a certain cubic equation are positive and unequal. In each pair of regions, the boundary curves are symmetrical with respect to the origin of coordinates, which is also the centre of the system. N.Dav

538.3

11022 **ELECTROMAGNETIC PRESSURE ON A CHARGE MOVING IN A MAGNETIC FIELD.** Ya.B.Fainberg and V.I.Kurilko.
Zh. tekh. Fiz., Vol. 29, No. 8, 939-45 (Aug., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 8, 855-60 (Feb., 1960).

The radiation pressure is equal to the momentum acquired by the charge per unit time from the scattered wave. This can be increased either by considering coherent scattering from an assembl of charges, or by using oscillators in place of charges. The latter case is considered in the nonlinear approximation. The subsequent motion of the oscillator is derived. Consideration is given to the effect of harmonics due to non-linearity in the oscillator. A .H.Gabri

538.3 : 530.1

ELECTROMAGNETIC WAVES IN GRAVITATIONAL FIELDS. See Abstr. 10568

538.3 : 550.

11023 **THE EQUILIBRIUM STABILITY OF A SYSTEM OF DISK DYNAMOS.** N.R.Lebovitz.
Proc. Cambridge Phil. Soc., Vol. 56, Pt 2, 154-73 (1960).

The stability of the equilibrium solutions of the equations describing the behaviour of a system of coupled disk dynamos is investigated. In the absence of viscous damping, it is found that systems consisting of more than two dynamos are unstable. That a single disk dynamo is stable is known. The stability of the undamp two-dynamo system has not been ascertained. When viscous damping is present, there are two equilibrium solutions, one in which al the currents are zero, and one in which they are finite. In the zer current case, a stability criterion is found. Stability criteria are also found in the finite-current case. Further, the existence of the finite-current equilibrium state excludes the stability of the zero-current equilibrium state.

538.3

11024 ON RAYLEIGH'S PROBLEM IN MAGNETOHYDRODYNAMICS. V.J.Rossow.

Phys. of Fluids, Vol. 3, No. 3, 395-8 (May-June, 1960).

A comparison is made of three flow fields that may be described as Rayleigh's problem in magnetohydrodynamics and that differ only in the state of motion of the magnetic field. Deviation of approximate expressions for the velocity from the more exact relations are also presented when the ratio of the viscous and magnetic Reynolds numbers is unity.

538.3

11025 THE HYDROMAGNETIC THEORY.

S.Colombo.

Cahiers de Phys., Vol. 12, 129-53 (April, 1958). In French.

A concise survey of the subject. The theory is based on the simultaneous solution of the Euler-Navier and Maxwell equations. It involves the integration of a system of non-linear partial differential equations. The concept of a hydromagnetic Reynolds number enables the forecast of some of the conditions which can be produced. Alfvén waves can be propagated in a liquid or gas in a magnetic field, and their existence is predicted by linearizing the fundamental equations.

A.H.Gabriel

538.3

11026 HYDROMAGNETIC WAVEGUIDE WITH FINITE CONDUCTIVITY AND ARBITRARY CROSS-SECTION.

.Shmoys and E.Mishkin.

Phys. of Fluids, Vol. 3, No. 3, 473-5 (May-June,1960)

Low pressure magnetohydrodynamic waveguides of arbitrary cross-section, having a d.c. axial magnetic field, exhibit both T.E. and T.M. modes. The longitudinal electric field vanishes when the conductivity of the plasma is infinite, converting the T.M. modes into principal ones. The propagation constants for both modes are derived from the solutions of the eigenvalue problems. Linearized magnetohydrodynamic equations are used.

538.3

11027 MOTION OF AN AXISYMMETRIC STREAM OF GAS OF LOW CONDUCTIVITY IN AN AXISYMMETRIC MAGNETIC FIELD. G.M.Bam-Zelikovich.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 1, 47-50 (March, 1960). In Russian.

Treats the hydromagnetic equations for a non-viscous thermally insulating gas with purely azimuthal currents and no azimuthal components of velocity or magnetic field. The method used is a series expansion in powers of the electrical conductivity. The zero-order motion chosen is one where the velocity is axial and constant inside a certain cylinder and is zero outside. The first-order equations are solved exactly for the case when the Mach number of the zero-order flow is 1; for other Mach numbers an expansion in powers of the cylinder radius is used.

O.Penrose

538.3

11028 THEORY OF RELATIVISTIC MAGNETOHYDRODYNAMIC WAVES. I.A.Akhiezer and R.V.Polovin.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1845-52 (June, 1959). In Russian. English translation in: Soviet Physics--JETP (New York), Vol. 36(9), No. 6, 1316-20 (Dec., 1959).

One-dimensional simple waves in relativistic magnetohydrodynamics and relativistic hydrodynamic discontinuities (contact, tangential, Alfvén, and fast and slow shock waves) are considered. The Zemplen theorem is proved for shock waves of arbitrary intensity.

538.3

11029 CYLINDRICAL AND PLANE MAGNETOHYDRODYNAMIC WAVES. K.P.Stanyukovich.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1782-7 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1271-4 (Dec., 1959).

Cylindrical waves produced in a conducting medium by a magnetic field are considered. The two cases when the field is directed along the z-axis and along the angle φ are analysed. Special attention is paid to "sound" waves, as well as to those possessing velocities close to that of light.

538.3

11030 ON THE PROPAGATION OF THE HYDROMAGNETIC WAVES IN COMPRESSIBLE IONIZED FLUID.

T.Taniuti.

Progr. theor. Phys., Vol. 19, No. 1, 69-76 (Jan., 1958).

A mathematical treatment of wave propagation due to the coupled motion of hydrodynamic flow and a magnetic field is given on the basis of the method of characteristics. Two simplifying assumptions are introduced: (a) the conductivity of the medium is infinite, and (b) the effect of the electric displacement current may be neglected. Special consideration is given to the occurrence of shock waves in unidimensional motion.

538.3 : 537.56

HYDROMAGNETIC DISTURBANCES IN A PLASMA.

See Abstr. 10912

538.3

11031 DYNAMIC PRESSURE ON AN OBSTACLE EXERTED BY A MOVING CONDUCTING LIQUID IN THE PRESENCE OF A MAGNETIC FIELD. E.Crausse and Y.Poirier.

C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2533-5 (April 4, 1960). In French.

Describes some experiments on the flow of mercury round a cylinder which demonstrate a large effect of magnetic field on the drag coefficient and on the angular distribution of pressures.

H.N.V.Temperley

538.3

11032 STABILITY OF AN IDEALLY CONDUCTING LIQUID FLOWING BETWEEN CYLINDERS ROTATING IN A MAGNETIC FIELD. E.P.Velikhov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1398-404 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 995-8 (Nov., 1959).

Sufficient conditions for the stability of an ideal liquid flowing in axial and toroidal magnetic fields are derived. Critical values of the magnetic fields which stabilize the flow are obtained and a physical interpretation of the results is presented.

538.3

11033 CALCULATIONS FOR INCLINED SHOCK WAVES IN MAGNETOGASODYNAMICS.

M.I.Kiselev and N.I.Kolosnitsȳn.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 4, 773-5 (April 1, 1960). In Russian.

Construction of a nomograph for the determination of wave velocity components from a cubic equation, obtained previously by Kiselev (Abstr. 13503 of 1959).

J.K.Skwirzynski

538.3

11034 STRUCTURE OF A MAGNETOHYDRODYNAMIC SHOCK WAVE IN A PARTIALLY IONIZED GAS. S.B.Pikel'ner.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1536-41 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1089-93 (Nov., 1959).

The wave consists of a thin plasma discontinuity and a transition zone. The equations for the transition zone are solved approximately for certain special cases. The charge-exchange effect does not significantly influence the general character of the motion but decreases its scale. As long as the wave can be considered stationary within the transition zone the magnitude of energy dissipation is independent of the degree of ionization.

538.3 : 537.56

11035 SOME PROBLEMS OF THE DYNAMICS AND HEATING OF A CONDUCTING MEDIUM IN A MAGNETIC FIELD.

G.S.Golitsȳn.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1062-7 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 756-60 (April, 1960).

One-dimensional motion of a perfectly conducting medium under the action of a magnetic field prescribed at the boundary is considered. Confinement of the plasma by a high frequency magnetic field is investigated. Some aspects of the problem of heating the plasma by magnetoacoustic waves are discussed.

538.3 : 532.5 : 536.2 : 621.313.2

THE THERMAL PROCESSES IN ELECTROMAGNETIC INDUCTION PUMPS.

See Abstr. 10792

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56 : 534 .2 : 532.5 : 621.372

11036 **SURFACE WAVE EXCITATION AND PROPAGATION.** J.B.Keller and F.C.Karal, Jr.
J. appl. Phys. Vol. 31, No. 6, 1039-46 (June, 1960).

A geometrical theory is developed for the analysis of surface-wave excitation and propagation. The surfaces along which the surface waves propagate may be either curved or flat, and may have either constant or variable properties. The theory is based on the concept of a complex or imaginary ray. The excitation coefficient which enters the theory is determined from the solution of a canonical problem — that of a line source over an impedance plane. Then the theory is applied to the surface wave excited by a line source, on a wedge with variable surface impedance. The result agrees precisely with the asymptotic form of the exact solution. Another application is made to the surface wave excited on a cylinder by a line source. The result also agrees with the exact solution.

538.56

11037 **ACTION-TRANSFER AND FREQUENCY-SHIFT RELATIONS IN THE NONLINEAR THEORY OF WAVES AND OSCILLATIONS.** P.A.Sturrock.
Ann. Phys. (New York), Vol. 9, No. 3, 422-34 (March, 1960).

Certain relations which have arisen in the theories of electrical networks, electron tubes, plasma oscillations, and particle accelerators are here shown to be special cases of general relations attributable to any system which may be described by a Hamiltonian. If such a system is analysed into an interacting set of modes (waves or oscillators), we find that the rates of transfer of action to or from members of a group of interacting modes are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. Furthermore a conjugate set of relations is found which lead to the following statement: the fractional shifts in frequency of members of a group of interacting modes, when multiplied by the energies in those modes, are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. The "action-transfer relations" allow one to draw a close parallel between the nonlinear theory of propagating media and the quantum or classical theories of particle collisions. These relations are closely related to the Poincaré and adiabatic invariants. The "frequency-shift relations" provide useful information relating the frequencies of uncoupled modes and the frequencies of excitation of these modes to the partition energy of this excitation among these modes. This application is demonstrated by a simple example.

538.56

11038 **TABLES OF EIGENVALUES AND MATRIX ELEMENTS OF TRANSITION PROBABILITIES FOR AN AXIAL SPIN HAMILTONIAN WITH $S = \frac{3}{2}$.** R.Stahl-Brada and W.Low.
Nuovo Cimento Suppl., Vol. 15, No. 3, 290-34 (1960).

The tables were compiled for the convenience of people working on three-level masers using chromium as the active material. Values are tabulated for a range of ratios of external magnetic field to zero field splitting, and for orientations of the external field at 5° intervals. J.M.Baker

538.56

11039 **MEASUREMENT OF THE FREQUENCY OF AN AMMONIA MASER IN ENGLAND AND AUSTRALIA.**
A.M.J.Mitchell and E.Sandbach.
Nature (London), Vol. 185, 833-4 (March 19, 1960).

Reports the results of frequency measurements made on an ammonia maser at Teddington and again when the maser was dismantled, shipped to Melbourne and set up again. The frequency in Australia was found to be 2.2 parts in 10^9 higher than that measured in England. R.C.Glass

538.56

11040 **USE OF SLOW MOLECULES IN A MASER.** N.G.Basov and A.N.Oraevskii.
Zh. eksper. teor. Fiz., Vol. 37, No.(10), 1068-71 (Oct.,1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 761-3 (April, 1960).

Several methods for improving the absolute frequency stability of a maser are considered; these methods are based on the use of molecular beams in which the mean velocity is much lower than the thermal velocity at room temperature.

538.56

11041 **ON THE POSSIBILITY OF MASER ACTION IN NUCLEAR QUADRUPOLE SYSTEMS.**
R.E.Donovan and A.A.Vuylsleke.
J. appl. Phys., Vol. 31, No. 3, 614-15 (March, 1960).

With reference to a proposal of Javan, (Abstr. 1794 of 1958) calculations were done on a system involving a nucleus with a nuclear quadrupole and Zeeman perturbation by a field perpendicular to an axially symmetric electric field gradient. From the pump-saturated level populations and the induced transition probabilities a magnetic Q is calculated which, at 4°K, is found two orders of magnitude bigger than a likely circuit Q. This was calculated for the case of iodine nuclei (I 5/2) in CH_3 I, which is thought to be a good material. It is concluded that maser operation with such a system is not possible with reasonable assumptions about spin—spin relaxation times. H.Motz

538.56 : 621.375.9

11042 **PROPOSED MOLECULAR AMPLIFIER AND COHERENT GENERATOR FOR MILLIMETER AND SUBMILLIMETER WAVES.** W.Gordy and M.Cowan.
J. appl. Phys., Vol. 31, No. 5, 941-2 (May, 1960).

Suggests a method of obtaining effective state selection in ammonia maser type devices at submillimetre wavelengths. If a collimated beam of symmetric-top molecules is passed through an electric field gradient, the $M \neq O$ states are scattered out of the beam leaving only $M = O$ states focused into the cavity. If a homogeneous Stark or Zeeman field is now applied to the molecules in such a way that $M = \pm 1$ transitions are stimulated, population inversion can be achieved and stimulated emission can occur between the $J + 1$, K, $M = O$, and the J, K, $M = \pm 1$ levels. G.D.Sims

538.56 : 621.375.9

11043 **SUPER-RADIATION AND SUPER-REGENERATION.** C.Greifinger and G.Birnbaum.
I.R.E. Trans Electron Devices, Vol. ED-6, No. 3, 288-93 (July, 1959).

The transient behaviour of a two-level spin system coupled to an electric circuit is investigated by using the equations of Bloembergen and Pound [Abstr. 8532 A of 1954; Phys. Rev., Vol. 95, 8-12 (July 1, 1954)]. The equations are solved, in the limit where the circuit ringing time is very short compared with all other characteristic times, for two cases : (1) the spin-lattice and spin—spin relaxation times both infinite, with an externally applied driving field; and (2) the spin-lattice relaxation time infinite but the spin—spin relaxation time finite, in the absence of an external field. In case (1), it is shown that the motion of an initially inverted magnetization under the action of an applied signal consists roughly of two stages : in the first stage, the effect of radiation damping is unimportant and the motion of the system is determined principally by the applied signal via the ordinary Bloch equations, whereas in the second stage, the motion is essentially the same as if the applied signal had been turned off and only radiation damping were present. In case (2), it is shown that a delayed peak in the emitted radiation should be observed under certain conditions. The delayed peak condition is identical with that derived by Bloom (Abstr. 8938 of 1958). Curves are presented showing the peak power and the time at which the delayed peak occurs as functions of the relevant parameters. In connection with the ordinary maser behaviour of a two-level spin system, it is shown that for values of the parameters typical of steady-state maser amplification, the effects of radiation damping should be unimportant. Finally, systems are examined for which the radiation damping time is much shorter than all other characteristic times (super-regenerative systems). It is indicated how such systems might be operated as one-shot multivibrators or as linear amplifiers. For the latter type of operation, an expression for the gain is derived which is found to be similar to that encountered in ordinary circuit theory.

538.56 : 621.317.74

11044 **HIGH RESOLUTION MILLIMETER WAVE FABRY—PEROT INTERFEROMETER.** W.Culshaw.
I.R.E. Trans Microwave Theory and Tech., Vol. MTT-8, No. 2, 182-9 (March, 1960).

The design and operation of a microwave Fabry—Perot interferometer at wavelengths around 6 mm is described. This uses reflectors which are simple, easy to make, and which are capable of scaling for operation at short wavelengths in the ultramicrowave region. With power reflection coefficients around 0.999, very sharp fringes and Q values around 100 000 were obtained on the interferometer. Effects of diffraction in the interferometer are considered, and wavelength measurements with this particular interferometer indicate that accuracies of 0.04% are obtained without any diffraction correction. Advantages of such an interferometer for ultramicrowaves are that the component parts are large compared with the wavelength, the effects of diffraction decrease with the wavelength, and the problem of maintaining a high Q with a single mode of propagation and a structure of adequate size is made much easier. Such an interferometer forms the cavity resonator for ultramicrowaves. It can thus be used for such conventional purposes as wavelength measurements, wavelength spectral analysis, dielectric constant, and loss measurements, or as the cavity resonator for frequency stabilization, or as the cavity resonator for a millimeter- or submillimeter-wavelength maser.

538.56

11045 ADAPTATION OF THE RADIOSONDE FOR DIRECT MEASUREMENT OF RADIO REFRACTIVE INDEX. A.H.Clinger and A.W.Straiton.

Bull. Amer. Meteorol. Soc., Vol. 41, No. 5, 250-2 (May, 1960).

Describes a technique for converting a radiosonde for direct measurement of the radio refractive index of the air using standard meteorological sensors. Although limited by the response time of the sensors, this device could provide for continuous and direct measurement of refractive index to an accuracy satisfactory for many radio applications.

538.56

11046 QUANTUM-MECHANICAL SEMICONDUCTOR GENERATORS AND AMPLIFIERS OF ELECTROMAGNETIC OSCILLATIONS. N.G.Basov, B.M.Vul and Yu.M.Popov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 587-8 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 416 (Feb., 1960).

Studies the possibility of using electronic transitions between the conduction band and donor or acceptor impurities in a semiconductor to obtain electromagnetic radiation by stimulation emission, in a similar way to that in a molecular generator [Basov and Prokhorov, Uspekhi fiz. Nauk, Vol. 57, 485 (1955)]. S.A.Ahern

538.56

11047 THE GROUP VELOCITY OF PLANE SURFACE WAVES. A.G.Mungall and D.Morris.

Canad. J. Phys., Vol. 38, No. 6, 779-86 (June, 1960).

The velocity of transmission of a modulated microwave signal over a dielectric-covered plane conductor was measured over a range of dielectric thicknesses for which the first order TM surface wave mode is known to propagate. An exact theoretical treatment of plane surface wave group velocity for both TM and TE surface wave modes of any order has been developed and calculations carried out for the first two orders. The experimentally determined signal velocities are in good agreement with the group velocities calculated for the first order TM mode. Effects of possible surface wave propagation on the accuracy of microwave distance-measuring methods are discussed.

538.56 : 537.56

A METHOD OF DETERMINING THE ELECTRON DENSITY OF A PLASMA BY MEANS OF THE GROUP VELOCITY. See Abstr. 10913

538.56

11048 ON THE INTERPRETATION OF HUYGENS' PRINCIPLE: ACOUSTIC, ELASTIC AND ELECTROMAGNETIC WAVES. III. P.Boillet.

Cahiers de Phys., Vol. 11, 306-32 (Aug.-Sept., 1957). In French.

Continuation of Abstr. 543 of 1958 and 1179 of 1959. A mathematical discussion of the general solution of Maxwell's electromagnetic equations in relation to Huygens' principle. J.G.Oldroyd

538.56

11049 AN ELECTROMAGNETIC WAVE-FRONT IN AN IONIZED GAS SUBJECTED TO A MAGNETIC FIELD. M. de Socio.

R.C. Accad. Naz. Lincei, Vol. 27, No. 6, 368-73 (Dec., 1959). In Italian.

An investigation of the behaviour of the derivatives of the intensities in the neighbourhood of the wave-front supplements a previous investigation (Abstr. 3672-3 of 1959) in which the method of Laplace transforms was used. R.A.Newing

538.56 : 537.56

MICROWAVE WHISTLER MODE PROPAGATION IN A DENSE LABORATORY PLASMA. See Abstr. 10916

538.56 : 539.2 : 538.27

FINITE AMPLITUDE ELECTROMAGNETIC WAVES IN GYROMAGNETIC MEDIA. See Abstr. 10190

538.56

11050 INHOMOGENEOUS WAVES IN THE DIFFRACTION FIELD CLOSE TO A LOSS-FREE DIELECTRIC CIRCULAR CYLINDER. V.Müller.

Z.angew. Phys., Vol. 12, No. 5, 206-12 (May, 1960). In German.

The method, based on Huygens' principle, of obtaining approximate solutions for the diffracted wave is described. It is shown that apart from the transmitted, reflected and refracted wavelets it is important to consider the highly attenuated wave which originates from a totally internally reflected wave, and emerges along the surface of the dielectric. The theory is compared with experimental results obtained with the aid of a parallel plate transmission line, using microwaves of 3.2 cm wavelength. K.W.Plessner

538.56

11051 DIFFRACTION OF A PLANE ELECTROMAGNETIC WAVE BY A PERFECTLY CONDUCTING DISK. K.A.Lur'e.

Zh. tekh. Fiz., Vol. 29, No. 12, 1421-33 (Dec., 1959). In Russian.

The problem can be solved exactly for any angle of incidence of the plane electromagnetic wave, by means of two simultaneous integral equations. It is shown that the current density on the disk, field intensity and the scattering coefficient can be derived as integrals of auxiliary functions, namely, the solutions of Fredholm's integral equations of the second kind, whose kernels are expressible in terms of tabulated functions. J.K.Skwirzynski

538.56

11052 THE PLANE PROBLEM OF DIFFRACTION OF ELECTROMAGNETIC WAVES BY AN IDEALLY CONDUCTING STRIP OF FINITE WIDTH. Yu.V.Pimenov.

Zh. tekh. Fiz., Vol. 29, No. 5, 597-603 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 532-8 (Nov., 1959).

The solution of the problem obtained by Nomura and Katsura (Abstr. 4180 of 1958) is applicable for plane waves only, and when small values of the product ka (where k is the wave number and a the half width of the strip) enable expansions of the functions in their formulae to be made. By imposing the restriction of small values of ka at the outset, the problem may be solved more simply, not only for the plane wave case, but also for the case of arbitrary external fields. G.D.Sims

538.56 : 537.56

11053 SCATTERING OF ELECTROMAGNETIC WAVES BY LONGITUDINAL PLASMA WAVES. P.Rosen.

Phys. of Fluids, Vol. 3, No. 3, 416-17 (May-June, 1960).

It is shown that Bragg reflection of electromagnetic waves from plasma oscillations is possible. The wave equation for the electromagnetic field passing through a medium of plasma waves is derived, and it is found to be similar to that of Brillouin for a wave in a medium of variable dielectric constant.

538.56

11054 ARTIFICIAL ANISOTROPIC DIELECTRICS FORMED FROM TWO-DIMENSIONAL LATTICES OF INFINITE BARS AND RODS. N.A.Khizhnyak.

Zh. tekh. Fiz., Vol. 29, No. 5, 604-14 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 539-48 (Nov., 1959).

A theoretical discussion of the scattering of electromagnetic waves by a single dielectric rod is given and the results are used to enable the permittivity, permeability and delay characteristic of a medium composed of a two dimensional lattice of infinite rods to be calculated. The case considered is that in which the electric vector of the incident wave is perpendicular to the rods and where the distance between the rods is small compared to the wavelength. G.D.Sims

538.56 : 621.372.8

11055 INVESTIGATION OF A HELIX-ANISOTROPIC DIELECTRIC AND HELIX-RIBBED STRUCTURE SLOW-WAVE SYSTEMS. I. V.P.Shestopalov and V.A.Slyusarskii.

Zh. tekh. Fiz., Vol. 29, No. 11, 1317-29 (Nov., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 11, 1212-22 (May, 1960).

The dispersion equations are obtained for a helix located in an anisotropic dielectric; the distribution of the power flow is also determined. The limiting case for the transition from a helix-anisotropic dielectric slow-wave system to a helix-ribbed structure slow-wave system is considered. The possibility of using a helix with a periodic variation in a travelling-wave tube is also considered.

538.56 : 537.2

SLOW WAVE PROPAGATION IN **HELIX-DIELECTRIC SYSTEM.** See Abstr. 10864. 10865

538.56 : 621.372.823

11056 **INFLUENCE OF PERIODIC ANNULAR SLOTS AND OF THIN DIELECTRIC LAYERS ON THE WAVE ATTENUATION IN CIRCULAR WAVEGUIDES.** V.P.Shestopalov and A.I.Adonina.
Zh. tekh. Fiz., Vol. 29, No. 12, 1457-61 (Dec., 1959). In Russian.

The dispersion equations for both TE and TM modes are quoted and wave attenuations are derived. The attenuation, different for TE and TM modes, depends greatly on the thickness of the dielectric layer. J.K.Skwirzynski

538.56 : 621.372.829

11057 **SPATIAL RESONANCE IN A SPIRAL WAVEGUIDE PLACED IN A MAGNETO-DIELECTRIC MEDIUM.**
V.P.Shestopalov and B.V.Kondrat'ev.
Zh. tekh. Fiz., Vol. 29, No. 12, 1434-56 (Dec., 1959). In Russian.

Dispersion equations are obtained and conditions for occurrence of spatial resonance are studied. The wave-numbers are derived as functions of frequency, the constants of the magneto-dielectric medium and the geometrical parameters of the spiral waveguide. J.K.Skwirzynski

538.56 : 621.372.829

11058 **SLOW ELECTROMAGNETIC WAVES IN HELIX WAVEGUIDES WITH A GYROTROPIC MEDIUM.**
V.P.Shestopalov and L.A.Shishkin.
Zh. tekh. Fiz., Vol. 29, No. 10, 1285-8 (Oct., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 10, 1179-82 (April, 1960).

The retarding properties of a helical waveguide situated in a gyrotropic medium with a magnetic field along the axis of the waveguide is considered theoretically. The dispersion equations are derived and the dispersion curves for forward and backward waves plotted. The dispersion equation for a helical waveguide surrounding a plasma is also obtained. R.C.Glass

538.56 : 621.391.812.3

11059 THE LOWER FREQUENCY LIMITS FOR F-LAYER RADIO PROPAGATION.
B.Fulton, O.Sandoz and E.Warren.
J. geophys. Res., Vol. 65, No. 1, 177-83 (Jan., 1960).

The band of frequencies propagated via the ionosphere by the high-angle ray and that propagated by the low-angle ray are both limited at their low-frequency ends by reflections that occur at lower ionospheric heights. Methods are developed for the calculation of these limits.

538.56 : 621.391.812.63

11060 SOME OBSERVATIONS OF IONOSPHERIC FARADAY ROTATION ON 106.1 Mc/s. R.A.Hill and R.B.Dyce.
J. geophys. Res., Vol. 65, No. 1, 173-6 (Jan., 1960).

The polarization twist imposed on 106.1 Mc/s radio waves by the ionosphere was investigated by using the moon as a passive reflector, the purpose being to determine the total electron column density even at altitudes above the known ionosphere. Because the aerial was capable of being continuously directed at the moon for 12 consecutive hours, observations were possible from the pre-dawn ionization minimum to the noon-time maximum. A true-height profile computed from vertical-incidence ionosonde data of September 16, 1957, suggests that the total electron content throughout the entire ionosphere is not a constant factor of the integrated electron content computed up to the level of maximum ionization density.

538.56 : 551.5

11061 GENERALIZATION OF THE APPLETON—HARTREE MAGNETO-IONIC FORMULA. H.K.Sen and A.A.Wyller.
Phys. Rev. Letters, Vol. 4, No. 7, 355-7 (April 1, 1960).

In laboratory experiments, electron—neutral collisional frequencies have been found to be dependent on the energy of the electrons. This fact has been used to generalize further the "friction" term of the Appleton—Hartree equations. The computed values of both the refractivity and absorptivity are significantly different for the classical and the generalized expressions when very low radio frequencies are considered. H.J.A.Chivers

538.56 : 551.5

11062 TWISTED RAY PATHS IN THE IONOSPHERE.
C.B.Haselgrove and J.Haselgrove.
Proc. Phys. Soc., Vol. 75, Pt 3, 357-63 (March, 1960).

It is shown how the Hamiltonian equations for a ray in an anisotropic medium can be used on an electronic computer to calculate ray paths in three dimensions in a model ionosphere. A programme was written for a digital computer and some ray paths were calculated.

Radiofrequency Spectroscopy Techniques

538.56

11063 **THE USE OF HIGH FREQUENCY MODULATION IN STUDYING FERROMAGNETIC RESONANCE.** Z.Frait.
Czech. J. Phys., Vol. 9, No. 3, 403-4 (1959).

An apparatus using a modulation frequency of 122 kc/s is described. A.J.Manuel

538.56

11064 **A TRANSISTOR [NUCLEAR MAGNETIC RESONANCE] SPECTROMETER WITH FREQUENCY MODULATION.**
C.Fric and H.Hahn.
C.R. Acad. Sci. (Paris), Vol. 250, No. 8, 1471-3 (Feb., 1960). In French.

A description is given of a spectrometer built with transistors containing an arrangement for frequency modulation using a variable capacity diode. The performance is compared with a valve oscillator of the same frequency of 30 Mc/s. J.M.Baker

538.56

11065 **STUDY OF THE FREQUENCY SHIFT AND AMPLITUDE OF OSCILLATIONS OF A [N.M.R.] SELF-OSCILLATOR OF THE FLOWING LIQUID MASER TYPE.** C.Fric.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2353-5 (March 28, 1960).

The resonant circuit of a maser is detuned in a known periodic manner and the corresponding shift of the emission frequency is measured. The influence of the liquid flow on the line width is also investigated. The tuning range obtained is from 1.7 kc/s (0.4 Gauss) to 29.6 Mc/s (7000 Gauss). J.M.Baker

538.56

11066 **A [NUCLEAR MAGNETIC RESONANCE] SPECTROMETE FOR HIGH RESOLUTION IN WEAK MAGNETIC FIELDS. DOUBLE RESONANCE IN AMMONIUM NITRATE.**
H.Benoit and H.Ottavi.
C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2708-10 (April 11, 1960). In French.

A spectrometer is described which operates at 12 kc/s using a liquid flow initially polarized in the high field of an electromagnet. The n.m.r. spectrum of protons in an aqueous solution of NH_4NO_3 and double resonance of the nitrogen nuclei are then described.

J.M.Baker

538.56

11067 **NUCLEAR RESONANCE MASER IN VERY WEAK FIELDS**
J.Hennequin.
C.R. Acad. Sci. (Paris), Vol. 250, No. 15, 2711-13 (April 11, 1960). In French.

The maser used is of a type already described (Abstr. 8346 of 1959) but using a specially designed electromagnet which allowed the observation of self oscillation in a field of 60 mG. By using a metho in which the liquid sample is made to flow around the axis of the coil oscillation is obtained at a frequency of 2.1 kc/s with a resonant circuit whose natural Q is 26. The turning motion of the sample effectively averages the field and produces a narrower line than is obtained when the liquid flows down the axis of the coil.

J.M.Baker

538.56

11068 SIGNAL TO NOISE RATIO IN NUCLEAR MAGNETIC RESONANCE. R.Chidambaram.

Proc. Phys. Soc., Vol. 75, Pt 1, 163-4 (Jan., 1960).

A calculation by Bloembergen et al. (Abstr. 2529 of 1948) of the signal-to-noise ratio to be expected in a nuclear magnetic resonance experiment is reanalysed. In the original treatment the signal-to-noise ratio is expressed in terms of Q and F, the quality factor of the sample coil and the noise figure of the amplifier. As F itself is a function of Q the author considers it preferable to represent the noise of the amplifier by an equivalent grid input resistance. The calculation of the signal-to-noise ratio is repeated with this change.
J.M.Baker

NUCLEAR AND ATOMIC PHYSICS

APPARATUS . PARTICLE DETECTORS

539.1.07

11069 ON THE SOURCE OF ERROR DUE TO FIELD DISTURBANCES, ON THE ACTIVITY MEASUREMENT OF RADIOCHEMICAL PREPARATIONS IN THE GAS-FLOW-COUNTER. A.Spang and W.Gebauhr.

Nukleonik, Vol. 1, No. 4, 160-4 (Dec., 1958). In German.

Activation measurements carried out with precipitates on filters, yield some results considerably outside the range of probable error. This is because the non-conducting filters disturb the high voltage field in the gas discharge counter. It was shown that the proper counting action can be restored in a 2π counter by placing the filter in an Al dish and covering it with a thin plastic film coated with Ag. Measurements were made on α- and β-ray sources with counters operating in their proportional and avalanche ranges. D.H.Lord

539.1.07 : 621.387.424

11070 THE PLATEAU SLOPE OF GEIGER COUNTERS WITH ARGON AND ETHYL ALCOHOL.

J.Franeau, F.Grard and R.Libert.

J. Phys. Radium, Vol. 19, Suppl. No. 7, 84A-90A (July, 1958). In French.

An experimental study of the plateau of Geiger counters, filled with a mixture of argon and ethyl alcohol, shows that the slope remains practically constant beyond a certain partial pressure of argon. Study of the causes of this slope show that at the beginning of the plateau they are due to differences in the height of the pulses; further on, the secondary pulses become an important cause, but these are not sufficient to explain the whole slope.

539.1.07

11071 ILLUMINATION SYSTEM FOR A WILSON CLOUD CHAMBER ALLOWING VISUAL OBSERVATION OF TRACKS OF SMALL CONTRAST. G.Corbé and T.Yuasa.

J. Phys. Radium, Vol. 19, No. 1, 110-11 (Jan., 1958). In French.

Describes an illumination system for an atmospheric Wilson cloud chamber which allows direct observation of electron tracks at energies greater than 100 keV with a chamber pressure of 10 cm Hg (air and water vapour). R.H.Thomas

539.1.07

11072 VARIATION OF THE PRESSURE IN A DIFFUSION CLOUD CHAMBER DURING THE FORMATION OF TRACKS AND POSSIBILITIES OF ITS USE. A.P.Komar and M.V.Stabnikov.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 4, 793-4 (Dec. 1, 1959). In Russian.

It has been found that during the formation of tracks a certain amount of the latent heat of condensation of the vapour filling is released, and this results in an increase of the temperature and hence of the pressure. When a 8 MeV α-particle track is formed, a pressure variation of 10^{-6} mm Hg is registered (the chamber volume is not given). A device based on differential pressure measurements has been used to select tracks of particles with a total ionization loss larger than a preset value. G.Martelli

539.1.07

11073 CHARACTERISTICS OF HEAVY ION TRACKS IN NUCLEAR EMULSIONS. P.G.Roll and F.E.Steigert.

Nuclear Phys., Vol. 16, No. 3, 534-44 (May (2), 1960).

Ilford G-5 nuclear emulsion plates were exposed in vacuum to beams of He^4, B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, F^{19}, and Ne^{20} ions. The ions were accelerated to about 10 MeV per a.m.u. degraded to the desired energy by a variable thickness of metal foil or gas, and analysed magnetically. Range—energy relations for these ions in dessicated G-5 emulsions were determined in this manner with an estimated accuracy of ±1%. Because the range—energy relations are intended for use in nuclear reaction experiments with machine-accelerated particles, no corrections were made for emulsion density. Comparison with similarly—exposed Ilford emulsions of various different grain sizes and sensitivities indicates no significant dependence of the range—energy relation on emulsion type. The track width was also measured in detail as a function of residual range for all ion species used.

539.1.07

11074 EFFECTIVE BACKGROUND SHIELD FOR LOW ACTIVITY MEASUREMENTS. A.P.U.Vuorinen.

Rev. sci. Instrum., Vol. 31, No. 5, 573-4 (May, 1960).

Details are given of the construction of a background shield for very low activity counting. The shield consists of two different materials, old iron and pure copper. The density of these materials is not the best possible but high enough to avoid large and expensive arrangements. The outer part of the shield is one-half of the 6 in. barrel of an old (1902) gun. The copper rings inside the cannon pipe are made by high vacuum casting of the purest (99.99%) electrolytic copper. The chill used in the vacuum melting and casting was made of reactor grade graphite. The age and form of the cannon barrel and the purity of the copper are the valuable points of the materials used. The whole construction, which weighed about 1400 kg., is relatively inexpensive. The background, measured with a NaI crystal, is reduced about 100 times by the shield. C.F.Barnaby

539.1.07

11075 MAGNETIC ENERGY ANALYSIS OF HIGH ENERGY PARTICLES. H.Tyrén and T.A.J.Maris.

Ark. Fys., Vol. 13, Paper 42, 609-18 (1958).

Technical details are given of the Uppsala magnetic spectrometer for 120-185 MeV protons. The necessity of a stable, well focused, monochromatic beam is stressed. The magnet calibration and transmission curves are reproduced and the method of obtaining them is described. Small displacements in beam energy and height are observed whose effect is minimized by the use of calibration peaks. The energy resolution is between 1.6 and 2.0 MeV and the reproducibility of spectral line intensities is about 5%. Spectra are liable to be badly defocused when the elastic peak is ~1000 times stronger than the average inelastic peaks as tends to occur at small scattering angles. A.Ashmore

537.1.07 : 537.534

DETERMINATION OF A TANGENT TO THE TRAJECTORY OF A CHARGED PARTICLE. See Abstr. 10979

NUCLEAR FIELD THEORY

539.11

11076 REGULARIZED VACUUM EXPECTATION VALUES IN QUANTUM FIELD THEORY. J.W.Moffatt.

Nuclear Phys., Vol. 16, No. 2, 304-12 (May (1), 1960).

A formal method of regularizing vacuum expectation values of Heisenberg current operators is introduced by imposing certain conditions on the spectral functions. The method is applied to Källén's calculation of the vacuum-polarization in an external electromagnetic field and leads to results which are explicitly gauge-invariant.

539.11

11077

SOME FEASIBLE TESTS OF QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES.

S.C.Frautschi.

Suppl. Progr. theor. Phys., No. 8, 21-32 (1958).

The limits of present knowledge of quantum electrodynamics, and the motivation for extending that knowledge, are reviewed. Precise measurements of the muon gyromagnetic ratio, and production of wide-angle electron and muon pairs in hydrogen by high-energy photons and electrons, are discussed as possible experiments which can extend out knowledge of electron, muon, and photon "size" to distances $\sim 0.3 \times 10^{-13}$ cm.

539.11

11078

RADIATIVE DEVIATIONS FROM THE COULOMB LAW AT SMALL DISTANCES.

V.G.Vaks.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1882-9 (June, 1959). In Russian. English tranlsation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1340-4 (Dec., 1959).

The radiative corrections to the Dirac equation in a Coulomb field are examined for distances $r \ll \hbar/mc$. The calculations are carried to the first order in $e^2/\hbar c$ and the second order in $Ze^2/\hbar c$. The resulting change in the Coulomb singularity of the wave-functions is small and is hard to distinguish from the effects of the finite size of the nucleus.

539.11

11079

ENERGY RENORMALIZATION IN ORDINARY WAVE MECHANICS.

M.Wellner.

Phys. Rev., Vol. 118, No. 3, 875-8 (May 1, 1960).

A very simple, exactly soluble compound-particle model, proposed by Wigner and Weisskopf in 1930, is briefly re-examined from the standpoint of renormalization. It consists of postulating, in the centre-of-mass system, the wave equations

$$[i(\partial/\partial t) + (1/2m)\nabla^2]\,\psi(x,t) = F(x)\chi(t),$$

$$[i(d/dt) - \mu]\,\chi(t) = \int d^3x\, F(x)\psi(x,t)$$

for two particles of separation x and reduced mass m, interacting through the formation and decay of an intermediate particle with a real form factor F. The analytic behaviour of the S matrix is discussed in the local case $F(x) = C\delta(x)$.

539.11

11080

EXAMPLE OF A SOLUBLE FIELD THEORY WITH FINITE CHARGE RENORMALIZATION.

H.M.Fried.

Phys. Rev., Vol. 118, No.5, 1427-9 (June 1, 1960).

A soluble field theory suggested by the models of Lee (Abstr. 9936 of 1954) and Machida (Abstr. 7964 of 1956) is described in which coupling constant renormalization arises from a dressed boson and is finite if the contributing fermions are assumed nonrelativistic. For the unrenormalized charge to be real, the renormalized charge must satisfy a certain inequality depending on the boson and fermion mass ratios; if this inequality is violated a single boson ghost state occurs, as expected.

539.11

11081

ANALYTICITY PROPERTIES OF PRODUCTION AMPLITUDES.

R.Ascoli and A.Minguzzi.

Phys. Rev., Vol. 118, No. 5, 1435-8 (June 1, 1960).

The analytic properties of production amplitudes are studied as functions of the momentum transfer Δ^2 between one of the incoming particles and one of the outgoing particles, when the total energy and the three further parameters determining the relative motion of the three outgoing particles in the centre-of-mass system are held fixed. It is found that suitable combinations of the amplitudes are analytic functions of Δ^2 regular within an ellipse in the Δ^2 plane. It is also shown that in the same domain the cross-section $\partial^2\sigma/\partial\Delta^2\partial\omega^2$ is an analytic and regular function of Δ^2, ω^2 being the total mass of two of the outgoing particles. The poles in Δ^2 conjectured by Chew and Low (Abstr. 7241 of 1959) never lie inside the domain of regularity.

539.11

11082

SELECTION RULE IMPOSED BY MASS REVERSAL.

T.Ouchi.

Progr. theor. Phys., Vol. 17, No. 6, 743-50 (June, 1957).

The structure of the interactions between the fundamental particles is studied by means of a selection rule based on the invariance principle of mass reversal. A unified model of interactions for the baryon—meson system is presented, and its consistency is proved using this selection rule. This selection rule is useful for exploring the dynamical structure of the interaction.

539.11

11083

ON THE ASYMPTOTIC CONDITIONS IN QUANTUM FIELD THEORY.

K.Nishijima.

Progr. theor. Phys., Vol. 17, No. 6, 765-802 (June, 1957).

Asymptotic conditions are introduced in a different way than usually, thereby making use of Heisenberg operators alone. These conditions are regarded as the defining equations for a complete set of state vectors, either incoming or outgoing wave states. By closely examining the self-consistency of these defining equations one obtains a set of integral equations for the vacuum expectation values of retarded products of operators. The unitarity condition of the S matrix is one of the inevitable consequences of these equations. These integral equations are essentially equivalent to those given by Chew and Low, and also independently by Lehamnn, Symanzik and Zimmermann. The advantage of the new integral equations over the older ones of those authors is that the new ones are manifestly covariant in form and also that all quantities appearing in the equations are related only to connected Feynman diagrams in contrast to the T products. The possibility to extend the present formalism so as to include bound states is also discussed. Finally, it is shown in the perturbation theory that these integral equations are satisfied only by the renormalized solutions of the renormalizable field theories provided that the microscopic causality condition is imposed as the boundary condition.

539.11

11084

THE PARITY CONSERVATION AND THE STRENGTH OF THE INTERACTION OF ELEMENTARY PARTICLES.

S.Tanaka.

Progr. theor. Phys., Vol. 18, No. 3, 295-313 (Sept., 1957).

In addition to the usual space and time, the two degrees of freedom which may be concerned in the mass of elementary particles are introduced. Based on the fundamental postulate with respect to the symmetry in the above new degrees of freedom, as well as the invariance under the proper Lorentz transformation, an attempt is made to formulate a theory and approach violation of the law of parity conservation and of the invariance under the particle conjugation in connection with the strength of interactions. It is shown that this theory has a close relation to the two-component neutrino theory proposed by Lee and Yang and also to Landau's theory.

539.11

11085

POSSIBLE RESONANCES IN WEAK INTERACTIONS AND TEST OF THE INTERMEDIATE BOSON HYPOTHESIS OF TANIKAWA AND WATANABE.

T.Kinoshita.

Phys. Rev. Letters, Vol. 4, No. 7, 378-80 (April 1, 1960).

The consequences of the weak decay theory of Tanikawa, assuming an intermediate neutral spinless boson B_1 with mass $>\sim 2300\, m_e$, are examined in the light of possible high-energy neutrino experiments. Taking a coupling constant to fit the observed β-decay, this predicts that a resonance should be observed in the reaction $\nu + n \rightarrow \mu^- + p$ at about 265 MeV with expected cross-sections in the observable range. By comparison with $\nu + n \rightarrow e^- + p$, the identity of the electron and muon neutrinos can be checked. Failure to observe these reactions would disprove the theory. R.F.Peierls

539.11

11086

SYMPLECTIC INVARIANCE AND THE PAIRING PROPERTY OF NUCLEAR INTERACTIONS.

I.Talmi.

Nuclear Phys., Vol. 6, No. 1, 153-7 (April, 1960).

The condition of symplectic invariance of a general two-body interaction in the j^n configuration is derived for all values of T without the explicit use of group theory. The relation of symplectic invariance to the pairing property is also discussed.

539.11

11087

CONSERVATION LAWS IN THE ISOTOPIC SPIN SPACE AND THEIR VIOLATION BY THE ELECTROMAGNETIC INTERACTION.

M.Kato and G.Takeda.

Suppl. Progr. theor. Phys., No. 7, 35-66 (1959).

The Σ^+-Σ^- mass difference and the electromagnetic correction to the $\Delta I = \frac{1}{2}$ law for the non-leptonic hyperon and K-meson decays are discussed, based on the assumption of charge impedence for the strong interactions. Simple calculation for the two phenomena reveals the difficulty that larger electromagnetic effects are needed than those discussed. Various approximate conservation laws in the isotopic spin space and their implications for the understanding of the non-leptonic decays are likewise discussed.

539.11

11088 ON THE STRUCTURE OF INTERACTIONS.

H.Umezawa.

Suppl. Progr. theor. Phys., No. 7, 67-85 (1959).

Theoretical and experimental knowledge on interactions is examined from the standpoint of the structure of elementary particles. A theoretical classification of interactions is given and the strong interactions are briefly discussed. Experiments on the weak interactions and their theoretical analysis are reviewed in detail. Some features which seem to play essential roles in extremely high-energy phenomena are studied.

539.11

11089 GENERAL THEORY OF INFRARED DIVERGENCE.

N.Nakanishi.

Progr. theor. Phys., Vol. 19, No. 2, 159-68 (Feb., 1958).

The problems of infrared divergence in perturbation theory are generally discussed, including not only photons but also neutrinos which interact with other particles in various ways. A completely general proof of the cancellation of infrared divergence in each order is given.

539.11

11090 ANOMALOUS SPINORS AND BOSONS.

A.M.Brodskii and D.D.Ivanenko.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1279-85 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 907-11 (Oct., 1959).

Besides "normal" spinors, "pseudospinors" and "mixed spinors" of various types are defined which have different transformation properties under space or time reflections. In particular, the "mixed" spinors realize what may be called anomalous representations: for them P and T commute. Further, for each type of spinors the customary four Yang—Tiomno classes are allowed for. Altogether one then obtains 64 distinct types of spinors. Their properties are examined and Lagrangians are set up. The possibility of anomalous commutation relations is illustrated. Finally, an attempt is made to identify various elementary particles with the various types of representation.

P.Roman

539.11 : 530.12

SPINORS IN REIMANN SPACE. See Abstr. 10554

539.11

11091 THE HYPOTHESIS OF THE INERTIAL EFFECT OF SPIN.

O.Costa de Beauregard.

Cahiers de Phys., Vol. 13, 200-8 (May, 1959). In French.

Discusses the concept of spin density and its representation in the Dirac theory of the electron. An inertial effect of spin is postulated whereby a inertial particle which acquires a spin density is subject to a law of conservation of total energy-momentum. The effect is illustrated by an example from ferromagnetism.

T.R.Carson

539.11

11092 SOME SIMPLE CORPUSCLE-FIELD MODELS IN THE NONLINEAR THEORY OF PARTICLES WITH SPIN.

G.Petiau.

Cahiers de Phys., Vol. 111, 429-63 (Nov., 1959). In French.

A study of particular examples of the principal properties of the solutions of systems of first order nonlinear wave-equations describing physical entities which are corpuscle-fields without the usual separation possible between the concepts of the corpuscular source of the field and the field generated by the corpuscle. For all the models examined (spin 0, spins 0 and $\hbar$, spin $\hbar/2$), the plane-wave solutions are expressed in terms of elliptic or associated hyperelliptic functions.

R.F.Peierls

539.11

11093 ON THE QUESTION OF THE MASS-SPECTRUM AND FUNDAMENTAL LENGTH IN THE THEORY OF FIELDS.

V.G.Kadȳshevskii.

Dokl. Akad. Nauk. SSSR, Vol. 131, No. 6, 1305-7 (April 21, 1960). In Russian.

A fifth coordinate is introduced to describe internal properties of a particle. It is considered to be canonically conjugate to the mass and restricted by periodicity. Then one obtains a mass-spectrum. Several comments are made regarding the change in the line element.

P.Roman

539.11

11094 ELEMENTARY FIELDS AND IRREDUCIBLE REPRESENTATIONS OF THE LORENTZ GROUP.

P.Hillion and J.P.Vigier.

Nuclear Phys., Vol. 16, No. 2, 360-73 (May (1), 1960).

With the help of a new representation of the Lorentz group in terms of complex relativistic Euler angles, a specific set of finite-dimensional vector spaces irreducible under Lorentz transformations is obtained. If every elementary particle family is associated with such a space, a set of wave equations is obtained, with an interesting new possibility for baryon waves.

539.11

11095 A THEORY OF ELEMENTARY PARTICLES.

T.Tati.

Progr. theor. Phys., Vol. 18, No. 3, 235-46 (Sept., 1957).

The theory is formulated without using space-time co-ordinates. The causality principle in the theory is given by the relation of the results of two measurements in the ordered observation (O_1, O_2). The causality principle used contains an undetermined constant (a four-vector), $C(O_1, O_2)$, The space-time is derived when the undetermined constants in the ordered observation $(O_1, O_2, O_3 ...)$ are given values by the law of probability. The field theory is valid only for "the local ideal system" which has no fluctuation of space-time. The limits of validity of the theory of relativity and the quantum mechanics based on the Schrödinger equation are given in terms of this theory. The difficulty of nonintegrability of the non-focal field theories which aim at avoiding the divergence difficulty disappears into the fluctuation of space-time in the theory. A view is mentioned that the spatial extension of the proton core found in high-energy electron scattering is possibly an observed effect of the fluctuation of the "space-time of the system" in this theory.

539.11

11096 HYPOTHETICAL VELOCITY MEASUREMENTS OF A DIRAC PARTICLE.

Z.Koba.

Suppl. Progr. theor. Phys., No. 8, 1-20 (1958).

The characteristic behaviour of a wave-packet of a Dirac particle immediately after a precise position measurement, which is essentially due to the presence of inner degrees of freedom or the commutativity of the position and the velocity operators, is reinvestigated in comparison with that of a fictitious one-component relativistic particle that has been examined by Aharonov and Bohm (Abstr. 46 of 1958) and is assumed to have only positive energy states. In order to distinguish this particle from a Dirac particle, another hypothetical experiment of three successive position measurements (a modification of the gedanken-experiment originally discussed by Dirac) is presented. Further, the procedure of this velocity measurement is analysed by a three-dimensional treatment, which reveals the polarity of the Dirac electron and illustrates the non-commutativity of different components of the velocity. Finally, the possibility of constructing an arbitrarily small wave-packet of a Dirac particle with positive energy states only, and the possibility of applying the present analysis to bosons, are discussed.

539.11

11097 NOTE ON A BARYON SCHEME.

Kh.Ȳiglane.

Zh. eksper. teor. Fiz., Vol. 37, No. 2, 558-9 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 394-5, (Feb., 1960).

The 32-dimensional spinor space spanned by the baryons may be treated as a representation of a 10-dimensional vector space. Four dimensions of this space are identified with ordinary Minskowski space—time, and the other six dimensions with an isotopic space. Five "spin operators" are defined in this space and a baryon wave-equation, discussed in a previous paper (Abstr. 5379 of 1959), is written down. The baryon structure appears to be characterized by three quantum numbers and the scheme is intimately related to those of Tiomno and Dallaporta. It is claimed that by a perturbational treatment all possible weak interaction transitions between baryons can be deduced.

P.Roman

539.11

11098 THE NUMBER OF ELEMENTARY BARYONS AND THE UNIVERSAL BARYON REPULSION HYPOTHESIS.

Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 569-70 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 403-4 (Feb., 1960).

It is pointed out that the hypothesis that there is one heavy fermion common to all baryons leads to the consequence of a strong repulsion of all baryons at small distances. No such repulsion arises between any baryons and any antibaryons. W.A.Hepner

539.11

11099 THE CONNECTION OF ISOTOPIC SPIN AND STRANGENESS WITH THE BEHAVIOUR OF SPINORS UNDER INVERSION.

A.M.Brodskii and D.D.Ivanenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 876-7 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 624-5 (March, 1960).

By allowing for factors −1, i, γ_5 appearing in addition to the usual ones in the space- or time-reflection properties of spinors, and by allowing for violation of space reflection invariance, a scheme which incorporates the isobaric properties of particles and explains the simultaneous breakdown of parity and strangeness conservation is arrived at. P.Roman

539.11

11100 THEORY OF THE RELATIVISTIC TRANSFORMATIONS OF THE WAVE-FUNCTIONS AND DENSITY MATRIX OF PARTICLES WITH SPIN.

V.S.Popov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1116-26 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol 37(10), No. 4, 794-800 (April, 1960).

Expansions are obtained for the wave-functions of a particle with spin s and for those of a system of two particles with arbitrary spins s_1 and s_2, in terms of the irreducible representations of the homogeneous Lorentz group; this makes possible a relativistically invariant classification of the states. For the invariant description of the polarization of free particles an expansion of the density matrix is found in terms of the irreducible representations of the Lorentz group.

539.11

11101 THE ONE-PARTICLE GREEN'S FUNCTION IN STATISTICAL QUANTUM MECHANICS.

R.Balian and C. de Dominicis.

Nuclear Phys., Vol. 16, No. 3, 502-17 (May (2), 1960). In French.

Some analytical properties of the mass operator are examined in perturbation theory, and a simple form of the one-particle Green' function for a grand canonical ensemble is obtained by analytical continuation. An approximation is then considered, which neglects terms where energy denominators are accidentally vanishing or equal. In this approximation, all quantities of interest can be diagrammatically built up like the corresponding ones for the ground state of a system of N particles; only the statistical factors for each state are no longer step functions in momentum space. The resulting expressions for "local" virial coefficients are examined, also the energy of the system fits in with the form Landau has assumed for his theory of Fermi liquids. In spite of difficulties arising from the use of a discrete spectrum of energies, this approximation is suggestive of what a more exact treatment could be.

539.11

11102 TWO TYPES OF NEUTRINO, LEPTON ISOTOPIC SPIN AND UNIVERSAL FOUR-FERMION INTERACTION.

É.M.Lipmanov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1054-7 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 750-2 (April, 1960).

It is suggested that two types of neutrino exist in nature (ν_1 and ν_2) which have identical longitudinal polarization but may have different lepton charges and which form, together with the electron and μ-meson, two isotopic lepton doublets ($\nu_1 e$) and ($\nu_2 \mu$). The electron and μ-meson lepton charges are also opposite. The laws of conservation of isotopic spin, lepton charge and chirality uniquely specify the nature of μ-decay and yield selection rules which exclude various unobservable reactions involving leptons.

539.11

11103 ANGULAR MOMENTUM EXPANSIONS IN RELATIVISTIC FIELD THEORY.

R.L.Warnock.

Phys. Rev., Vol. 118, No. 5, 1447-54 (June 1, 1960).

As a step toward more general applications of angular momentum expansions in quantum field theory the expansion of the scattering matrix is examined in the case of scattering of spin 0 by spin $\frac{1}{2}$ particles. The matrix is represented in terms of its eigenvalues and eigenvectors, the latter being eigenstates of total angular momentum. Using eigenstates of helicity to simplify the discussion, the eigenvectors may sometimes be obtained from the conservation laws alone. The eigenvalues are computed only to second order in a Yukawa interaction, but the results are more useful than the usual second-order matrix elements. Since angular momentum expansions lead effectively to solutions of operator equations, the expressions derived facilitate the relativistic application of Heitler's unitary approximation (with an exact solution of the equation relating the transition operator T and the Hermitian reaction operator K) or the determinantal method of Schwinger and Baker.

539.11

11104 STATIC MODEL IN THE MESON THEORY.

M.Sugawara.

Progr. theor. Phys., Vol. 18, No. 4, 383-95 (Oct., 1957).

A non-linear static model is constructed from the relativistic γ_5-theory, by approaching the static limit after a canonical transformation is applied to the original γ_5-Hamiltonian, with no perturbation expansion used. It is then proved that the same analysis as due to Chew and Drell et al. of P- and S-wave pion—nucleon scattering can be applied even for the general non-linear static model obtained, as far as the one-meson approximation is concerned. In this model, however, various renormalized coupling constants are uniquely defined in terms of the unrenormalized ps—ps coupling constant. Furthermore, their numerical values depend in general on the types of the process concerned; the renormalized P-wave coupling constant effective in pion—nucleon scattering is different from one determining threshold gamma—pion production. Rough numerical estimations of these renormalized coupling constants are made for two transformations found by Dyson and by Foldy. The results seem qualitatively satisfactory, including a strong meson-pair term damping, though a definite conclusion is not yet possible.

539.11

11105 ON THE EFFECTIVE COUPLING STRENGTH IN THE STATIC PION THEORY.

T.Kobayashi, J.Osada and S.Tani.

Progr. theor. Phys., Vol. 18, No. 1, 89-91 (July, 1957).

It is shown how the apparent coupling between different spin and isobaric spin states, which occurs in the Chew—Low equation describing pion—nucleon scattering, can be removed by a simple rearrangement of the equation. The effective coupling constant in the new equation is a function of the energy, and the energy variation is given for certain special cases. E.J.Squires

539.11

11106 SCATTERING LENGTH AND EFFECTIVE RANGE THEORY FOR MULTICHANNEL PROCESSES.

M.H.Ross and G.L.Shaw.

Ann. Phys. (New York), Vol. 9, No. 3, 391-415 (March, 1960).

The threshold properties of a two-body system which is coupled to other two-body channels are investigated. In particular the new channel is examined when it is coupled to only one other, open, channel. At the threshold of the new channel three real parameters (which describe the scattering amplitudes) are considered: the complex scattering length, $a = A - iB$, in the new channel and the diagonal K matrix element in the old channel, c. The quantitative behaviour of these parameters is first established with respect to certain averaged strengths of the interactions. An interesting application is, for example, a relation between the three actual paramete and the c that would apply if the coupling between the channels were turned off. Effective range expansions exist for the three paramete (These can be easily generalized to the problem of many old channel These have the same form as the familiar one-channel expansion, except that the coefficient, r_0, of the quadratic term in the expansio is now an effective range type integral multiplied by a factor depending on a and c. For example, in the effective range expansion of a, it is found that if Im(1/a) is large (compared to a kinematical factor roughly the momentum, k_1, in the old channel) r_0 will be large compared to the range of forces. A similar result applies for the effect range expansion of the length c/k_1. The usefulness of some of the relations is illustrated by solving, exactly, the problem in which the two-channel system is described by two coupled Schrödinger equati with square-well potentials. The scattering length is also examine by means of a complex potential for the situation where there are many coupled channels.

539.1

11107 USE OF THE SCATTERING AMPLITUDE TO RECONSTRUCT THE POTENTIAL NEAR ITS BOUNDARY

A.G.Chicherin.

Zh. eksper.teor. Fiz., Vol. 36, No. 6, 1750-7 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1248-52 (Dec., 1959).

The asymptotic Born approximation is formulated from the scattering amplitude for a potential that coincides with the true potential at sufficiently large radii. The order of magnitude of the relative error in the determination of the scattering potential at a point r is

$$\int_r^\infty U(r')\,r'dr'.$$

The case where the scattering amplitude is given in a finite energy interval is considered.

539.11

11108 BOUNDS FOR ELASTIC AND INELASTIC SCATTERING.

A.Weinmann.

Proc. Phys. Soc., Vol. 75, Pt 4, 510-19 (April 1, 1960).

Two methods are given for obtaining bounds for functions satisfying certain systems of coupled integral equations. Application to the integral equations for potential scattering (elastic or inelastic, three-dimensional or in partial-wave expansion) results in bounds for the wave-functions, and hence for the scattering amplitudes and cross-sections. The method gives sufficient conditions for the convergence of the Born iteration series, and estimates for the truncation errors for a wide variety of problems. A simple example illustrates the methods. It is also indicated how they can be employed in more complicated situations than those considered here.

539.11

11109 FORMAL MULTI-CHANNEL SCATTERING THEORY. AN ALTERNATIVE FORMULATION.

G.Grawert and J.Petzold.

Z. Naturforsch., Vol. 15a, No. 4, 311-19 (April, 1960). In German.

An alternative of Jauch's (Abstr. 6526 of 1959) formulation of multi-channel scattering is developed in the framework of non-relativistic quantum mechanics. The time development of the system is described by the Schrödinger picture and state vectors and channels are defined in a rigorous mathematical manner by considering asymptotic properties. Møller-operators are introduced and a formalismus entailing several S-matrices, corresponding to transitions between pairs of channels, is developed. It is shown that the exclusion principle can be easily incorporated by means of antisymmetrization. P.Roman

539.11

11110 THE THEORY OF SCATTERING VIA QUASI-STATIONARY STATES.

V.I.Serdobol'skii.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1903-8 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1354-7 (Dec., 1959).

The continuous-spectrum wave-function that describes S scattering is expanded in series in terms of a system of wave-functions of quasi-stationary states with complex energies. The validity of the expansion is established by a study of the analytic properties of the solution. The resulting dispersion formulae express the energy dependence of the cross-section in a more convenient way than that provided by previous theories.

539.11

11111 THEORY OF SCATTERINGS AND REACTIONS.

Y.Yamaguchi.

Suppl. Progr. theor. Phys., No. 7, 1-34 (1959).

Using the concepts of "eigen-phase shifts" and "eigen-channels", multichannel processes such as nuclear reactions are discussed. A simple derivation of one-level formula is given. This formulation of collision processes enables one to write down explicitly the reaction amplitudes in such cases where interference between resonance and potential scattering exists, or two resonance levels are close together within their widths. Situations are discussed in which reactions via Bohr's "compound nucleus" occur. Finally, an anomaly (e.g., "cusp" behaviour) of the elastic scattering at the threshold where a new channel becomes open is discussed. An elementary method is employed which is a straight-forward generalization of Bethe's derivation of effective range theory.

539.11

11112 A SIMPLIFIED PROOF OF DISPERSIVE RELATIONS.

T.S.Chang.

Science Record (China), New Series, Vol. 3, No. 12, 623-7 (Dec., 1959).

This paper presents what is claimed to be "a simple but not rigorous proof" of dispersion relations for meson—nucleon and potential scattering. P.K.Kabir

539.11

11113 INVESTIGATION OF THE CHEW—LOW EQUATION BY ITERATION.

H.Fujino and J.Osada.

Progr. theor. Phys., Vol. 17, No. 6, 751-64 (June, 1957).

The Chew—Low equation of P-wave meson—nucleon scattering (Abstr. 2680 of 1956) is investigated by an iteration method to provide a means of obtaining the values of Feynman diagrams without any renormalization procedure. At the same time, the physical meaning of the one-meson approximation of the Chew—Low equation is made clear.

539.11

11114 REMARKS ON CHEW—LOW EQUATIONS.

T.S.Chang.

Science Record (China), New Series, Vol. 3, No. 12, 628-30 (Dec., 1959).

The wave-functions in the Chew—Low formalism and in the conventional formal theory of scattering are identical apart from a constant multiple which represents the scalar product of the wave-functions of a physical nucleon and a bare nucleon. Conditions on the existence of solutions of the Chew—Low type are examined. T.R.Carson

539.11

11115 INCOMPATIBILITY OF THE ANALYTICITY AND UNITARITY CONDITIONS IN LEE'S MODEL.

K.A.Ter-Martirosyan.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1005-9 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 714-17 (April, 1960).

It is shown that outside the framework of the Hamiltonian formalism, and when only selection rules characteristic of Lee's model (Abstr. 9936 of 1954) are taken into account, the analyticity condition leads to a contradiction (even in the simplest $N + \theta$ sector) with the unitarity condition. Due to the presence of cross symmetry this contradiction does not arise in the usual meson theories (at least for a static nucleon in the one-meson approximation which in Lee's model is analogous to the case of a $N + \theta$ sector).

539.11

11116 CALCULATION OF PHASE INTEGRALS IN THE COVARIANT FORMULATION OF THE THEORY OF MULTIPLE PRODUCTION OF PARTICLES.

L.G.Yakovlev.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1041-5 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York, Vol. 37(10), No. 4, 741-3 (April, 1960).

A method is proposed for exact calculation of integrals over momentum space in the covariant statistical theory of multiple particle production. The method is applicable to other modifications of the theory although the calculations become more complicated. Approximate and exact calculations are performed.

539.11 : 539.12

11117 THRESHOLD DISCONTINUITIES: APPLICATION TO X-RAY SCATTERING.

R.G.Newton and L.Fonda.

Ann. Phys. (New York), Vol. 9, No. 3, 416-21 (March, 1960).

It is shown that, in contrast to elastic and partial reaction cross-sections, the total cross-section averaged over the Coulomb resonances is continuous at the threshold of a channel of two outgoing oppositely charged particles. An instance in which the effects discussed should be experimentally observable is the elastic scattering of X-rays near a photoelectric threshold. It is shown that the discontinuity in that case should equal the size of the photoeffect cross-section.

539.11

11118 ON THE STATISTICAL APPROXIMATION TO THE WAVE-MECHANICAL MANY-BODY PROBLEM. II.

K.Ladányi.

Acta phys. Hungar., Vol. 7, No. 2, 267-72 (1957). In German.

For Pt I, see Abstr. 7305 (1960). By using a suitable form for the single particle wave-functions in a Hartree—Fock variational method, the statistical model expression for the energy is obtained even for a relatively small number of particles. A generalization of the method and neglect of the Weizsäcker term leads to the Bloch equation for the energy. E.J.Squires

539.11

11119 INTRODUCTION OF MANY-PARTICLE VARIABLES FOR THE TREATMENT OF SPECIAL TRANSLATIONALLY INVARIANT MANY-BODY PROBLEMS. P.Möbius.
Nuclear Phys., Vol. 16, No. 2, 278-303 (May (1), 1960).

An attempt is made to treat special translationally invariant many-body problems by coordinate transformations introducing many-particle variables. These are adapted coordinates of such kind that the condition of translational invariance and the Pauli principle can be satisfied automatically. They are homogeneous functions of the particle coordinates obeying certain differential equations. The Schrödinger equation is transformed into these variables. There exist examples of systems of interacting particles which can be separated exactly in the many-particle variables but not in the particle coordinates.

539.11

11120 ON THE STATISTICAL TREATMENT OF THE FERMION GAS. I. P.Szépfalusy.
Acta phys. Hungar., Vol. 9, No. 1-2, 203-16 (1958).

A new statistical method, very similar to the one generalized to contain the Weizsäcker inhomogeneity correction modified by Gombás (1956), is derived. The summation over quantum states can be carried out exactly. In addition to the determination of the density from the variation principle, more accurate methods are described. It is shown that from Plaskett's equation (Abstr. 4215 of 1956) the density can only be determined within the classical "allowed zone", and the proper equation for the "forbidden zone" is given.

539.11

11121 ON THE STATISTICAL TREATMENT OF THE FERMION GAS. II. P.Szépfalusy.
Acta phys. Hungar., Vol. 9, No. 3, 335-42 (1959).

Considers the three-dimensional case.

539.11

11122 THE ENERGY OF A COMPRESSED IMPERFECT FERMI GAS. D.A.Kirzhnits.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 585-7 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 414-15 (Feb., 1960).

The approximation used by Gell-Mann and Brueckner for a high-density electron gas is applied to a Fermi gas with interactions whose range is finite but large compared to the distance between particles. J.Goldstone

539.11

11123 CALCULATION OF SINGLE-PARTICLE ENERGIES IN THE THEORY OF NUCLEAR MATTER.
K.A.Brueckner, J.L.Gammel and J.T.Kubis.
Phys. Rev., Vol. 118, No. 5, 1438-41 (June 1, 1960).

The rearrangement energy corrections to the single-particle energies have been evaluated, using the procedure of Brueckner and Goldman. The shift is shown to be due largely to the second- and third-order rearrangement energy diagrams, the corrected energy at the Fermi surface now nearly agreeing with the mean binding energy. The change of the single-particle energies of virtual excitations due to rearrangement effects is also determined and shown to shift the mean binding energy by 1.5 MeV.

539.11 : 536.48

11124 LEVEL STRUCTURE OF NUCLEAR MATTER AND LIQUID He^3.
K.A.Brueckner, T.Soda, P.W.Anderson and P.Morel.
Phys. Rev., Vol. 118, No. 5, 1442-6 (June 1, 1960).

Using the K matrix as computed in the study of nuclear matter and liquid He^3 as the effective interaction at the Fermi surface, the possible superfluidity of these systems has been investigated. A theory of the cooperative phenomenon valid for particle—particle interaction in states of arbitrary angular momentum has been developed following the methods of Bardeen, Cooper and Schrieffer. It is found for states of relative angular momentum other than $l = 0$ that the particle pairs must be correlated with respect to an arbitrary direction in the medium. As a result the change of structure of the Fermi surface is angularly dependent. An energy gap does not occur other than for $l = 0$, the particle excitation energy vanishing for certain orientations of the momentum. It is also shown that the specific heat shows a discontinuity at the transition temperature, but somewhat different from the case of $l = 0$. Application of these results to liquid He^3 shows that the cooperative effects arise from the interaction in the state with $l = 2$, and that the transition temperature is at about 0.1° K. In nuclear matter the $^1S_0$ interaction is very weak and probably repulsive at the Fermi surface, and the attractive $^1D_2$ interaction gives a negligible energy shift. The $^3S_1$ interaction is attractive and in nuclear matter gives a few-tenths of an MeV energy gap. These results suggest that in finite nuclei, with pairing of identical nucleons in the same shell, the cooperative effects are not strictly analogous to those in nuclear matter but instead are closely associated with the finite level spacing.

539.11

11125 STRUCTURE OF NUCLEAR MATTER. A.W.Overhauser.
Phys. Rev. Letters, Vol. 4, No. 8, 415-18 (April 15, 1960).

It is shown that it is possible that the Hartree ground state of a Fermi gas contains static density waves, i.e., that the self-consistent field is periodic, not uniform. Whether this happens in nuclear matter is investigated. J.Goldstone

ELEMENTARY PARTICLES

539.12

11126 MASS OF ELEMENTARY PARTICLES. S.C.Horning.
Nature (London), Vol. 186, 708 (May 28, 1960).

As a numerological curiosity, the masses of the elementary particles are calculated approximately using Planck's constant, the fine structure constant and the base of the natural logarithms. S.J.St-Lorant

539.12

11127 THE WEAK INTERACTIONS. S.B.Treiman.
Sci. American, Vol. 200, No. 3, 72-8, 80, 82-4 (March, 1959).

A non-specialist account of the study of weak interactions, and the information so far yielded. A pictorial table is given of the fundamental particles, their symbols, masses, lifetimes and decay modes. Particular attention is paid to the subjects of parity and antimatter symmetry.

539.12 : 539.1

11128 ASIMUTHAL SYMMETRIES IN CASCADE REACTIONS AND PARITY CONSERVATION. M.I.Shirokov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1524-32 (May, 1959). In Russian. English translation in: Soviet Physic—JETP (New York Vol. 36(9), No. 5, 1081-6 (Nov., 1959).

Cascade reactions such as proton—proton triple scattering are covered by the formalism which is completely general. The relatio derived are of the type $\sigma(\theta, \varphi ; \theta', \varphi') = \sigma(\theta, -\varphi ; \theta', -\varphi')$ where on scattering takes place at angles θ, φ and the other at θ', φ'. The relations follow from parity conservation in each reaction, and apply to all observables. Experiments suggested are a more stringent test of parity conservation than the usual, well-known azimuthal sy metry in single scattering. D.W.L.Sprun

539.1

11129 EFFECT OF VISCOSITY IN MULTIPLE PRODUCTION ON THE ENERGY DISTRIBUTION OF SECONDARY PARTICLES. A.A.Emel'yanov and D.S.Chernavskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1058-61 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 753-5 (April, 1960).

The effect of viscosity on processes occurring in a simple wa is considered in the hydrodynamical theory of multiple production of particles. It is found that at sufficiently high energies the effec of viscosity on the energy distribution of the fastest particles may significant.

Photons

539.12 : 539.14 : 530.12

DETERMINATION OF THE APPARENT WEIGHT OF PHOTONS, USING γ-RAY RESONANT ABSORPTION BY Fe^{57}. See Abstr. 10570

539.12

11130 THE DISPERSION RELATIONS FOR THE SCATTERING OF PHOTONS FROM PROTON. T.Akiba and I.Sato.
Progr. theor. Phys., Vol. 19, No. 1, 93-111 (Jan., 1958).

Dispersion relations are derived for the non-forward amplitudes for photon—proton scattering. By expanding these relations in momentum transfer and retaining the first few terms, the dispersion relations for six independent combinations of the partial wave amplitudes are obtained. Contributions of the unphysical region are calculated to the first order in the fine structure constant, and are ound to be consistent with the low-energy theorem. Using these relations and photopion production data, the differential cross-sections are calculated. In doing this, the amplitudes for the mixtures of dipole and quadrupole waves are taken into account in addition to electric dipole, electric quadrupole and magnetic dipole amplitudes. The results are a fair improvement on the dipole model, and roughly explain experimental data.

539.12

11131 THE RELATIONSHIP BETWEEN ENERGY ABSORPTION AND IONIZATION FOR γ-QUANTA WITH $E_{\gamma_{max}} = 85$ MeV. S.P.Kruglov and I.V.Lopatin.
Zh. tekh. Fiz., Vol. 29, No. 2, 273-5 (Feb., 1959). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 4, No. 2, 240-1 (Feb., 1959).

The percentage of γ-ray energy absorbed in different thicknesses of lead was measured by a calorimetric method. Proportionality with the integrated ionization was found to fail definitely at a thickness of 30 mm. This was considered to be due to softening of the liberated electron spectrum. Agreement between the measured energy loss and reduction in γ-ray intensity was only found for large distances between the absorber and the calorimeter. A.Ashmore

539.12

11132 SCATTERING OF A PHOTON ON A NUCLEON IN THE ONE-MESON APPROXIMATION. E.D.Zhizhin.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 994-9 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 707-10 (April, 1960).

Scattering of a photon on a nucleon proceeding via strong interaction is treated with allowance for exchange of a single virtual π-meson. The scattering matrix is computed for angular momentum values up to $J = \frac{7}{2}$. The angular distributions for reactions involving polarized particles are presented.

539.12

11133 ABSORPTION OF GAMMA RADIATION IN NaI WELL CRYSTALS. M.H.Wächter, W.H.Ellett and G.L.Brownell.
Rev. sci. Instrum., Vol. 31, No. 6, 626-30 (June, 1960).

The results of Monte Carlo calculations on the detection and otal absorption peak efficiencies of spherical NaI crystals are presented. A method of applying these data to cylindrical well crystals of arbitrary size and well geometry is described and the results are compared with experimental data. The Monte Carlo computations cover the gamma-ray energy range from 200 keV to MeV and crystal radii from 1.5 to 12.0 cm. Histograms are resented of the number of Compton scattering events which a .662 MeV gamma ray undergoes in crystals of different sizes.

539.12 : 539.14

11134 DEVELOPMENTS IN GAMMA-RAY OPTICS. P.B.Moon.
Nature (London), Vol. 185, 427-9 (Feb. 13, 1960).

A short review of recent work on the spectroscopy, scattering nd resonance processes of gamma-rays. Particular attention is iven to the Mössbauer effect (Abstr. 9040 of 1958) in which emission ccurs with recoil of the whole lattice instead of a single atom, so hat the emission line is extraordinarily sharp. Some of the possible pplications of this effect in research in both nuclear and solid state hysics are suggested. V.E.Cosslett

539.12

11135 A COMPTON-ELECTRON γ-SPECTROMETER WITH TWO-DIRECTIONAL FOCUSING. G.E.Lee-Whiting.
Canad. J. Phys., Vol. 38, No. 6, 720-1 (June, 1960).

Improvements in the design of one type of Compton-electron spectrometer for γ-rays are proposed. The design requires a magnetic field of cylindrical symmetry and of slow radial variation, a simply curved radiator, and a system of apertures. Electrons are accepted only if they are ejected from the radiator with small components of momentum in two orthogonal directions perpendicular to the incident γ-ray. Since the magnetic field can also be used to measure the momentum of the selected electrons, the instrument can function as a γ-ray spectrometer. Higher-order aberrations are discussed, and a method of calculating the values of the various spectrometer parameters corresponding to maximum efficiency is given. Calculations of the intrinsic line-width, caused by the motion of the electron within the atom before collision with the photon, are carried out.

539.12

11136 IMPROVED GAMMA DETECTOR USING GAMMA MODERATION. R.Foz.
Rev. sci. Instrum., Vol. 31, No. 6, 612-15 (June, 1960).

Theoretical and experimental results of the effect of gamma moderation are described. A $\frac{1}{8}$ in. thick sodium iodide crystal and a Co^{60} gamma source were used to check the increased counting efficiency due to gamma moderation predicted by theory. The gamma source and detector were imbedded in a gamma moderator. The count rate in the gamma moderated system was found to be 6.7 times greater than in the bare system. A counter was designed and built to make the most use of gamma moderation. The results indicate that this counter can be made energy independent or energy dependent, the controlling factor being the size of the gamma moderator surrounding the detector. Though the cost of one of the counter assemblies is less than that of a 1 in. diam 1 in. thick sodium iodide crystal plus photomultiplier, the counting efficiency for Na^{24} gammas is over two times greater.

539.12

11137 ENHANCEMENT OF BREMSSTRAHLUNG PRODUCED BY 575 MeV ELECTRONS IN A SINGLE CRYSTAL OF SILICON. A.N.Saxena.
Phys. Rev. Letters, Vol. 4, No. 6, 311-12 (March 15, 1960).

Improved methods were used to study the enhancement of bremsstrahlung produced by high-energy electrons when they pass through a single crystal. Preliminary results demonstrating the enhancement of the soft component are presented. No attempt is made to examine the quantitative agreement between the results and theory. J.D.Dowell

X-rays

539.12 : 539.11

THRESHOLD DISCONTINUITIES: APPLICATION TO X-RAY SCATTERING. See Abstr. 11117

539.12 : 537.533

11138 MICROSCOPY WITH X-RAYS. G.Dupouy, F.Perrier and P.Verdier.
C.R.Acad. Sci. (Paris), Vol. 250, No. 19, 3083-8 (May 9, 1960). In French.

A short description of the projection X-ray microscope built at the Electron Optics Laboratory of C.N.R.S. at Toulouse. It is modelled on that of Cosslett and Nixon (Abstr. 5509 of 1953), having two magnetic electron lenses and operating at 3 to 20 kV. Microradiographs are reproduced at magnifications varying from 20 up to 500. A best resolution of 0.3 μ is claimed. V.E.Cosslett

539.12

11139 DETECTION AND CORRECTION OF NONLINEARITY IN X-RAY PROPORTIONAL COUNTERS. M.A.Short.
Rev. sci. Instrum., Vol. 31, No. 6, 618-20 (June, 1960).

A simple procedure is described for the detection and correction of nonlinearity in X-ray proportional counters. This procedure is shown to be superior to the simple version of the multiple foil method. Under typical working conditions a General Electric 1 SPG counter was found to be linear (to within 0.03%) up to 4000 counts/sec.

Neutrinos

539.12 : 537.54

11140 FEASIBILITY OF USING HIGH-ENERGY NEUTRINOS TO STUDY THE WEAK INTERACTIONS. M.Schwartz.
Phys. Rev. Letters, Vol. 4, No. 6, 306-7 (March 15, 1960).

An order-of-magnitude estimate is made which shows that the observation of high-energy neutrino interactions is beyond the capabilities of present accelerators, but barely feasible with the 3 GeV Princeton and 10 GeV Argonne proton synchrotrons. A.Ashmore

539.12 : 523.87

11141 EMISSION OF NEUTRINO PAIRS BY ELECTRONS AND THE ROLE PLAYED BY IT IN STARS.
G.M.Gandel'man and V.S.Pinaev.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1072-8 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 764-8 (April, 1960).

Bremsstrahlung emission of neutrino pairs by a nondegenerate gas is investigated. In a certain range of high densities and temperatures, the energy loss by bremsstrahlung emission of neutrino pairs becomes greater than the loss due to radiative thermal conductivity. The inclusion of the energy loss due to neutrino pair emission may turn out to be significant, and in some cases even of decisive importance, for the theory of white dwarfs and stellar evolution, particularly for the dynamics of supernova explosions. The process under consideration leads to even greater energy losses than the process of neutrino pair formation in the reaction proposed by Gamow and Schoenberg (Abstr. 1362 of 1941).

Electrons

539.12 : 538.3

11142 INVESTIGATION OF THE RATIO OF INTENSITIES OF THE POLARIZED COMPONENTS OF RADIATION EMITTED BY A "LUMINOUS" ELECTRON.
F.A.Korolev and O.F.Kulikov.
Optika i Spektrosk., Vol. 8, No. 1, 3-7 (Jan., 1960). In Russian.

The ratio of the polarized components of the visible (4000-6000 A) radiation of electrons accelerated in a synchrotron was recorded photographically for various maximum electron energies (150, 200 and 250 MeV). A satisfactory agreement between experimental and theoretical values of this ratio was obtained. [The electrons are called "luminous" because they emit visible radiation].
A.Tybulewicz

539.12

11143 BETA INTERACTION AND NUCLEON FORM FACTOR. V.B.Berestetskii and I.Ya.Pomeranchuk.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1321-2 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36 (9), No. 4, 936 (Oct., 1959).

The cross-section for the process

$$e + p \rightarrow n + \gamma$$

is calculated taking into account the nucleon form-factor.
C.J.Batty

539.12

11144 SCATTERING OF A LOW-ENERGY ELECTRON BY A SHORT-RANGE POTENTIAL IN A STRONG MAGNETIC FIELD. V.G.Skobov.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1467-9 (Nov., 1959). In Russian.

The radius of action of the scattering field is taken to be small compared with the wavelength of the electron. The wave-function of the electron is determined and the scattering probability deduced. Behaviour of the energy levels is discussed.
A.E.I. Research Laboratory

539.12

11145 ELECTRON—ELECTRON SCATTERING CROSS-SECTION AT HIGH ENERGIES. V.I.Baier.
Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1490-2 (Nov., 1959). In Russian.

A general formula is presented for electrons having charge and current distributions $f_1(q^2)$, $f_2(q^2)$. Exchange of a single photon is considered, and the formula reduces to Møller scattering when $f_1 = 1$, $f_2 = 0$.
D.W.L.Sprung

539.12

11146 MEASUREMENT OF ENERGY LOSS OF FAST ELECTRONS BY PASSAGE THROUGH MATTER.
I.A.Grishaev, A.N.Fisun, A.S.Litvinenko, V.M.Grizhko, B.I.Shramenko and I.N.Onishchenko.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1455-6 (Nov., 1959). In Russian.

The energy loss of 18 MeV electrons in aluminium, in hydrocarbons $(C_8H_8)_n$, and in $(C_4H_8O_2)_n$ was measured and compared with the predictions of the theories of Landau (Abstr. 23 of 1947), Fermi (Abstr. 1626 of 1940) and Goldwasser et al. (Abstr. 902 of 1953). The last-named theory consistently underestimates the observed energy loss by a few percent. The Landau—Fermi theory gives exact agreement, within experiment error, in the care of $(C_8H_8)_n$, and overestimates by a few percent in other cases.
J.W.Gardner

539.12

11147 THE POLARIZATION OF THE ELECTRONS IN BREMSSTRAHLUNG PROCESSES. A.A.Kresnin.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 872-3 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 621-2 (March, 1960).

The change of the polarization of an electron beam due to the bremsstrahlung process is investigated theoretically.
W.A.Hepner

539.12

11148 IONIZATION LOSS NEAR THE ORIGIN OF AN ELECTRON PAIR OF VERY HIGH ENERGY.
I.Mito and H.Ezawa.
Progr. theor. Phys., Vol. 18, No. 4, 437-47 (Oct., 1957).

The ionization loss of a negatron-positron pair is calculated as a function of their distance of separation. This result will be useful in measuring the energy of a γ-ray above 10^{10} eV from the reduction of ionization near the origin of the created pair. The reduction is due to the interference between the electromagnetic field of the negatron and that of the positron. A similar method is adopted to that of Fermi, who treated the energy loss of a single electron taking into account the polarizability of the medium. The result is similar to Čudakov's [Izv. Akad. Nauk SSSR, Vol. 19, 650 (1955)] provided the distance between the negatron and positron is small. See also Abstr. 2974, 8857 of 1957.

539.12

11149 PAIR PRODUCTION IN THE FIELD OF THE ELECTRON FROM TOTAL PHOTON ABSORPTION IN LIQUID HYDR GEN FROM 155 MeV TO 255 MeV. W.B.Jones.
Ann. Phys. (New York), Vol. 9, No. 3, 341-53 (March, 1960).

The transmission of liquid hydrogen for photons was measured in the energy range 155 MeV to 255 MeV. An electron synchrotron was used as the radiation source and a magnetic pair spectrometer served as the photon detector. The total cross-section of hydrogen for photons in the energy interval is nearly constant and has an average measured value of 18.7 ± 0.4 millibarns/atom. The objective of the experiment was to obtain a measure of the cross-section for pair production in the field of the free electron. An analysis of the data indicates that the pair-production cross-section in the field of the electron is smaller by 0.5 ± 0.4 millibarn/electron than the pair-production cross-section in the field of the unscreened proton.

539.12

11150 ON PAIR-PRODUCTION BY THE COLLISION OF TWO CIRCULARLY POLARIZED GAMMA-RAY QUANTA.
F.S.Sadÿkhov and B.K.Kerimov.
Zh. eksper. teor. Fiz. Vol. 36, No. 4, 1324-6 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 938-9 (Oct., 1959).

The electron—positron pair production in the collision of two circularly polarized γ-ray quanta is calculated taking into account the longitudinal polarization of the pair particles. C.J.Batt

539.1

11151 EFFECT OF MULTIPLE SCATTERING ON PAIR PRODUCTION BY HIGH-ENERGY PARTICLES IN A MEDIUM. F.F.Ternovskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1010-16 (Oct., 1959. In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 718-22 (April, 1960).

The effect of multiple scattering on pair production by a fast charged particle passing through a medium is considered. The calculations are carried out by a method previously developed by Migdal [Dokl. Akad. Nauk SSSR, Vol. 96, 49 (1954); Vol. 105, 77 (1955); Abstr. 5186 of 1958].

539.12

11152 THREE-PHOTON ANNIHILATION OF POSITRONIUM IN THE P-STATE. A.I.Alekseev.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1839-44 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1312-15 (Dec., 1959).

A relativistically invariant expression for the probability amplitude for this process is obtained by the summation of an infinite number of diagrams of a definite class. The probability of three-photon annihilation of positronium in the P-state is calculated in the nonrelativistic limit, and the selection rules for this process are found.

Nucleons

539.12

11153 PION AND ELECTROMAGNETIC STRUCTURE OF NUCLEONS. B.B.Dotsenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1478-9 (Nov., 1959). In Russian.

Assuming that external fields have a negligible effect on the nucleon structure, an estimate is made of the contribution of three-meson processes. The root-mean-square radius of the proton and neutron are found to be 0.76 f and 0.19 f respectively. The contribution of the three-meson process to the magnetic moment of the nucleon is estimated to be less than a tenth of that due to the two-meson process. A.M.Green

539.12

11154 SOME CONSIDERATIONS ON THE HIGH-ENERGY ELECTRON—PROTON SCATTERING AND THE NUCLEON MASS DIFFERENCE. K.Hiida and M.Sawamura.

Progr. theor. Phys., Vol. 18, No. 5, 451-61 (Nov., 1957).

High-energy electron—proton scattering experiments at Stanford (1956) are analysed in connection with the small mass difference of the nucleons. If nucleons are rigid bodies, then it is shown that a consistent interpretation is obtained when one ascribes to the electron a finite size of the same order as those of nucleons. Discussions of this result are extended to other related phenomena.

539.12

11155 ELECTROMAGNETIC STRUCTURE OF THE PROTON AND NEUTRON.

D.I.Blokhintsev, V.S.Barashenkov and B.M.Barbashov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1611-12 (May, 1959). In Russian. English translation in Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1145-6 (Nov., 1959).

The total charge and magnetic moment density are calculated for a nucleon consisting of a core and a meson cloud in which only the single pion state is considered. The results are compared with experimental values. C.J.Batty

539.12

11156 ANTINUCLEON—NUCLEON INTERACTIONS.

Z.Koba and G.Takeda.

Progr. theor. Phys., Vol. 19, No. 3, 269-84 (March, 1958).

A simple model for the nucleon—antinucleon interactions is presented, in which the nucleon or the antinucleon is regarded as composed of two parts, the pion cloud and the "core". The latter is characterized by two properties: (a) it acts as a nearly black body for an incoming antiparticle wave; and (b) its characteristic time for annihilation is much shorter than the oscillation period of the outer pion cloud. These simple assumptions lead to natural semi-quantitative explanations of the salient features of the experimental information so far available concerning the nucleon—antinucleon reaction and capture processes. Some arguments are advanced to justify this approach.

539.12

11157 TESTS OF CHARGE INDEPENDENCE OF NUCLEON—NUCLEON INTERACTIONS.

G.Breit, M.H.Hull, Jr, K.Lassila and K.D.Pyatt, Jr.

Phys. Rev. Letters, Vol. 4, No. 2, 79-81 (Jan. 15, 1960).

The results of a detailed phase-shift analysis of n—p and p-p scattering data are used as a test of charge independence. In the first test the higher phase shifts are calculated by a one-pion exchange potential and hence the pseudoscalar coupling constant found. There is no significant difference between the values obtained in the n—p and p—p cases. In the second test T = 1 phase shifts were allowed to vary from the best values obtained from p—p data in order to see whether this enables better fits to be made to the n—p data. In fact it was found that the best values of the T = 1 phase shifts were not significantly different in the two cases. E.J.Squires

539.12

11158 NUCLEON INTERACTION CROSS-SECTIONS AT 9 GeV ENERGY.

V.S.Barashenkov and Huan Nen-Ning.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1319-21 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 935-6 (Oct., 1959).

It is shown that above 1GeV the experimental evidence is in agreement with the equality of cross-sections for nucleon—nucleon interactions with bound and free nucleons, taking the density distribution in the nucleus from electron-scattering measurements. In this region nucleon—nucleon cross-sections are sensitive to the diffuseness of the nucleon boundary. A.Ashmore

539.12

11159 THE POSSIBLE INFLUENCE OF NUCLEON STRUCTURE IN HIGH-ENERGY INTERACTIONS. Zh.S.Takibaev.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 633-4 (Feb., 1960). In Russian.

Proposes a relation between the degree of angular anisotropy and the distribution of the transverse momentum component for the particles in a shower. This relation is shown to agree with current ideas on nucleon structure. A.M.Green

539.12

11160 NUCLEON—NUCLEON SCATTERING IN HIGH ANGULAR MOMENTUM STATES. A.F.Grashin.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1717-24 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1223-8 (Dec., 1959).

The properties of the one-meson approximation to elastic nucleon—nucleon scattering are considered in detail, and the scattering phase shifts are calculated. A new method of phase-shift analysis is proposed, which should lessen the ambiguity of the solution and make it possible to get more accurate values of the experimental phase shifts.

539.12

11161 TENSOR AND SPIN—ORBIT FORCES IN NUCLEON—NUCLEON SCATTERING. R.Tamagaki.

Progr. theor. Phys., Vol. 20, No. 4, 505-28 (Oct., 1958).

Nucleon—nucleon scattering at 150 MeV is analysed in order to investigate the effects of a tensor force and to examine the necessity of introducing a spin—orbit force at high energies. The analysis is made taking into account some characteristic features of the pion-theoretical nuclear forces. It is shown that the experimental data around 150 MeV can be well explained by two main features of nuclear forces: (a) a strong tensor force in the outer part of the interaction and (b) a hard-core-like repulsive interaction in the inner part. It is emphasized that the former feature, which is the most characteristic one of the pion-theoretical nuclear forces, is decisively important at such high energies as well as at low energies. No positive evidence is found for such spin—orbit forces as play an important role around 150 MeV. This conclusion is in conflict with the prediction of very strong spin—orbit forces recently made by Signell and Marshak and by Gammel and Thaler. It is shown that Signell and Marshak's spin—orbit coupling potential comes from their undue reliance on the inner part of Gartenhaus' potential.

539.12

11162 MULTIPLE MESON PRODUCTION IN ANTINUCLEON—NUCLEON ANNIHILATION. N.Yajima and K.Kobayakawa.

Progr. theor. Phys., Vol. 19, No. 2, 192-200 (Feb., 1958).

Assuming that the whole system establishes a statistical equilibrium, the authors adopt the temperature of the system as the only parameter, and, deciding the critical temperature in the similar way as Landau, [Izv. Akad. Nauk SSSR, Vol. 17, 51 (1953)] obtain numerical values which agree with experimental data and clear up the question why one must take a large magnitude of the interaction volume as a parameter in the Fermi statistical model.

Protons

539.12

11163 THE REACTION $p + p \to p + p + \pi^0$ IN THE ENERGY RANGE FROM THRESHOLD TO 665 MeV.

A.F.Dunaitsev and Yu.D.Prokoshkin.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1656-71 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1179-90 (Dec., 1959).

The angular distributions of π^0-mesons produced in proton—proton collisions was investigated at 400-665 MeV. The distributions were found to be close to isotropic, in agreement with Mandel'shtam's phenomenological resonance theory (Abstr. 4241 of 1958). The total cross-sections were measured in the energy range 313-665 MeV. At energies above 400 MeV, the main contribution to the reaction cross-section is made by resonance transitions. At lower proton energies, the non-resonant Ss transition becomes significant, its contribution to the total cross-section being $0.032\,\eta_m^2 \times 10^{-27}$ cm^2 (where η_m is the maximum π^0-meson momentum in the c.m.s.). A comparison of the measured cross-sections of neutral and charged pions with the cross-sections calculated from the resonance theory indicates that the transition with the total angular momentum $J = 3$ plays the predominant role.

539.12

11164 PROTON—PROTON SCATTERING AT 98 AND 142 MeV.

A.E.Taylor, E.Wood and L.Bird.
Nuclear Phys., Vol. 16, No. 2, 320-30 (May (1), 1960).

The differential cross-section and the polarization in proton—proton scattering were measured over the angular range 5° to 90° cm at 98 and 142 MeV. For angles greater than 37° cm, the variation of the differential cross-section can be expressed as $4.01 \pm 0.19\,[1 - (0.02 \pm 0.045)\cos^2\theta]$ at 142 MeV and as $4.41 \pm 0.21\,[1 + (0.02 \pm 0.07)\cos^2\theta]$ at 98 MeV, and the polarization cross-section $P(d\sigma/d\omega)/\sin 2\theta$ can be expressed as $(0.805 \pm 0.021) + (0.339 \pm 0.063)\cos^2\theta$ and as $(0.54 \pm 0.05) - (0.04 \pm 0.12)\cos^2\theta$ at 142 and 98 MeV respectively.

539.12

11165 PROTON—PROTON SCATTERING AT 25 MeV.

T.H.Jeong, L.H.Johnston, D.E.Young and C.N.Waddell.
Phys. Rev., Vol. 118, No. 4, 1080-1 (May 15, 1960).

The differential cross-section for proton—proton scattering was measured for 23 centre-of-mass angles from 10° to 90°, with ±0.8 absolute probable error at angles greater than 14°. The incident proton energy was 25.63 MeV lab. The 90° cross-section is 18.59 millibarns, and the interference minimum of 17.09 mb occurs at 24° c.m. A set of phase shifts which fit the data are: $^1S_0$, 49.5°; $^3P_0$, 8.2°; $^3P_1$, −4.2°; $^3P_2$, 2.0°; $^1D_2$, 0.62°.

539.12

11166 R PARAMETER IN p—p SCATTERING AT 142 MeV.

L.Bird, D.N.Edwards, B.Rose, A.E.Taylor and E.Wood.
Phys. Rev. Letters, Vol. 4, No. 6, 302-3 (March 15, 1960).

Preliminary results are presented for the measurement of the Wolfenstein R parameter using 142 MeV polarized protons. The second scattering was produced in the horizontal plane after first rotating the polarization vector into the transverse horizontal direction by means of a solenoid. Scattering angles from 20° to 90° centre-of-mass were investigated and the values of R determined show qualitatively the trend predicted by the Signell—Marshak and Gammel—Thaler potentials. J.D.Dowell

539.12

11167 ELASTIC SCATTERING OF 8.5 BeV PROTONS ON PROTONS.

V.B.Lyubimov, P.K.Markov, É.N.Tsȳganov, Chzhen Pu-In [Cheng P'u-Ying] and M.G.Shafranova.
Zh. eksper. teor. Fiz., Vol. 37, No. 4 (10), 910-14 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 651-5 (April, 1960).

Photographic emulsions were used to study p—p scattering at an energy of 8.5 BeV. The irradiation geometry was such that the incident protons were perpendicular to the plane of the photographic emulsion. Sixty-six events of elastic scattering were found. Scattering on quasi-free protons and other background effects comprised about 2%. The elastic scattering cross-section was (8.4 ± 1.1) millibarns. The differential cross-section down to 2.5° in the c.m.s. was derived. Near 0° it is larger than would be expected on the basis of a purely absorbing proton model.

539.12

11168 THEORETICAL INTERPRETATION OF INELASTIC p—p AND p—n COLLISIONS AT 9 BeV.

V.S.Barashenkov, V.M.Mal'tsev and É.K.Mikhul.
Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1484-6 (Nov., 1959). In Russian.

The experiments agree on the whole with the statistical theory, which shows that most of the events are due to central collisions of the two particles. Differences in the small-angle data and in the relative abundance of single-particle creation events are ascribed to peripheral collisions. D.W.L.Sprung

539.12

11169 MEASUREMENT OF THE POLARIZATION OF DEUTERONS IN THE REACTION $p + p \to d + \pi^+$ WITH 670 MeV PROTONS.

Yu.K.Akimov, K.S.Marish, O.V.Savchenko and L.M.Soroko.
Rev. de Physique (Bucarest), Vol. 4, No. 3, 359-71 (1959). In Russian.

The polarization of deuterons produced in the reaction $p + p \to d + \pi^+$, using 670 MeV protons, was measured at the three centre-of-mass angles 121°, 140° 30′ and 162°. The amplitude for the p-transition $^1S_0 \to {}^3S_1 p_0$ is found, and its contribution to the total cross-section is about 1%. The angular dependence of the deuteron polarization does not contradict the assumption that the transition amplitudes from the $^3F_2$- and $^3F_3$- proton states are zero.

A.M.Green

539.12

11170 ELECTROMAGNETIC CORRECTIONS TO THE RATIO $\sigma(p + d \to H^3 + \pi^+)/\sigma(p + d \to He^3 + \pi^0)$.

H.S.Köhler.
Phys. Rev., Vol. 118, No. 5, 1345-50 (June 1, 1960).

Electromagnetic corrections to the ratio between charged and uncharged pions produced along with either a triton or He^3 from 600 MeV protons incident on deuterium were estimated. It was found that the main correction comes from the difference in triton and He^3 wave-functions. It was not found possible to correct unambiguously for the effects of mass difference between charged and uncharged pions. An enhancement of around 10% of positive pions was obtained with an estimated uncertainty of ±3%. The result agrees with experiments at CERN (Abstr. 368 of 1960).

539.12

11171 SOME DATA ON THE INTERACTIONS OF HIGH-ENERGY PROTONS IN LIGHT NUCLEI (C,O).

F.Fiorini and S.Ratti.
Nuovo Cimento, Vol. 14, No. 4, 901-4 (Nov. 16, 1959). In Italian.

The angular distributions of the products of the interactions of about 300 protons in the Plexiglass plates of a cloud chamber triggered by cosmic rays are compared with the predictions of a Monte Carlo calculation, as developed by Combe (Abstr. 1589 of 1957).

G.Martelli

539.1

11172 ANTIPROTON INTERACTIONS IN HYDROGEN AND CARBON BELOW 200 MeV.

L.E.Agnew, Jr, T.Elioff, W.B.Fowler, R.L.Lander, W.M.Powell, E.Segrè, H.M.Steiner, H.S.White, C.Wiegand and T.Ypsilantis.
Phys. Rev., Vol. 118, No. 5, 1371-91 (June 1, 1960).

About 500 antiprotons in a partially purified antiproton beam were observed to enter a 30 in. propane bubble chamber. An arrangement of counters identified the antiproton events, thus reducing scanning to a minimum and also providing a sample of antiprotons free of scanning bias. The antiprotons entered the propane at a kinetic energy of 220 MeV and were brought to rest. Scatteri and annihilation interactions in both hydrogen and carbon were observed as a function of antiproton energy. Differential scattering cross-sections were obtained, and the following total cross-sectio were measured for antiproton kinetic energies, T, in the ranges to 137.5 MeV and 137.5 to 200 MeV:

Interaction	Cross-section, σ (mb) $75 \leq T \leq 137.5$	Cross-section, σ (mb) $137.5 \leq T \leq 200$
(p̄—p) elastic	66 ± 17	56 ± 14
(p̄—p) annihilation	112 ± 23	60 ± 18
(p̄—C) elastic [5° (lab) cutoff]	345 ± 60	255 ± 45
(p̄—C) annihilation	474 ± 76	360 ± 65

These results show satisfactory agreement with the Ball—Chew theory where comparison can be made. In contrast to previous studies of annihilation products, it was possible to make a direct observation of the neutral pions through pair production by π^0 decay photons. The significant results for carbon and hydrogen annihilations at an average antiproton kinetic energy ≅ 100 MeV are:

Annihilation product	Hydrogen annihilations: Multiplicity	Hydrogen annihilations: Average total energy (MeV)	Carbon annihilations: Multiplicity	Carbon annihilations: Average total energy (MeV)
π^-	1.53 ± 0.08	402 ± 21	1.58 ± 0.07	366 ± 13
π^+	1.53 ± 0.08	379 ± 19	1.33 ± 0.08	371 ± 13
π^0	1.60 ± 0.50	356 ± 110	1.15 ± 0.30	342 ± 90

In addition to the above-listed annihilation products, the carbon stars contained nucleons that carried off more than 188 MeV per star. When pion absorption is considered, the carbon result of 4.1 ± 0.3 pions per annihilation is consistent with the observed hydrogen multiplicity of 4.7 ± 0.5 pions. Pion energy spectra and frequency distributions, as well as other details, were obtained. Seventeen strange particles were identified among the products of all the annihilations. This indicates that the production of a pair of K-mesons occurs in (4.0 ± 1.0)% of all annihilations. The average total energy per K pair is greater than 1200 MeV. The charge-exchange process $\bar{p} + p \rightarrow \bar{n} + n$ were observed and, based on six possible events, the result $\lambda \geq 630$ g cm^{-2} was obtained for the mean free path in propane ($50 \leq T_{\bar{p}} \leq 150$ MeV).

Neutrons

539.12 : 530.16

NEUTRON TRANSPORT: THE RANDOM WALK PROBLEM. See Abstr. 10618

539.12

11173 SOME REMARKS ON THE TWO-COMPONENT THEORY OF LEE AND YANG. A.A.Sokolov.

J. nuclear Energy, Vol. 9, No. 1-4, 212-13 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 385 (1958).

A comparison is made of the Lee and Yang two-component neutrino theory and an alternative neutrino theory in terms of Dirac particles with oriented spin. They lead to opposite definitions of the neutrino and antineutrino. R.F.Peierls

539.12

11174 ASYMMETRIES IN THE BETA DECAY OF POLARIZED NEUTRONS. M.A.Clark and J.M.Robson.

Canad. J. Phys., Vol. 38, No. 5, 693-5 (May, 1960).

According to Jackson et al. (Abstr. 6508 of 1957), the angular distribution of the products of the β-decay of polarized neutrons contains the following terms:

$$A \frac{\vec{J}}{J} \cdot \frac{\vec{p}_e}{E_e} + B \frac{\vec{J}}{J} \cdot \frac{\vec{p}_\nu}{E_\nu} + D \frac{\vec{J}}{J} \cdot \left(\frac{\vec{p}_e}{E_e} \times \frac{\vec{p}_\nu}{E_\nu} \right)$$

using their notation. This result allows for the possible failure of parity conservation and time reversal invariance. Experiments to determine the coefficient D have been completed [see Clark et al. (Abstr. 2596 of 1959)] and give the result D = −0.14 ± 0.20, which is consistent with time reversal invariance. Further experiments have been carried out to determine the asymmetry of the coincidence rate between electrons and protons in the decay, with respect to the direction of the polarization vector J. These give B = +0.96 ± 0.40. It is shown that this result, together with recent data on the half-life of the neutron, establish clearly that the vector interactions in the neutron decay are in opposite phase. R.E.Meads

539.12

11175 ELECTRON—NEUTRINO ANGULAR CORRELATION IN THE BETA-DECAY OF THE FREE NEUTRON.

Yu.V.Trebukhovskii, V.V.Vladimirskii, V.K.Grigor'ev and V.A.Ergakov.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1314-16 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 931-2 (Oct., 1959).

The electron—neutrino angular correlation in the β-decay of the free neutron was determined by studying the decay-electron spectrum for a fixed proton recoil momentum. The results give $\lambda = -0.06 \pm 0.13$, and hence $R = g_a^2 / g_V^2 = 1.3^{+1.5}_{-0.53}$, compared with the value R = 1.4 obtained from neutron-lifetime measurements. C.J.Batty

539.12

11176 ANALYSIS OF NEUTRON—ELECTRON INTERACTION IN THE RELATIVISTIC PERTURBATION THEORY.

K.Ishida.

Progr. theor. Phys., Vol. 18, No. 5, 493-502 (Nov., 1957).

The experiments of Hughes et al. (Abstr. 5724 of 1953) indicate that the charge distribution of the physical neutron is almost neutralized by the cancellation of the nucleon core and the meson cloud charges, which can hardly be expected from the fixed source theory. On the other hand, the relativistic ps-coupling theory, which indicates that both the nucleon core and the meson cloud spread out over the region of about twice the nucleon Compton wavelength, seems to be more promising. In this paper, the effective neutron—electron potential is analysed using perturbation, evaluating separately for each time-ordered graph so as to compare with the result of the fixed source theory. It is found that: (1) owing to the nucleon recoil effect, the p-wave meson contribution is only about 1/2.3 times the one in the fixed source theory; (2) the (−) energy state contribution for the nucleon core charge is as large as that of (+) energy state; and (3) s-wave meson contributions, which are not involved in the fixed source theory, are taken into account qualitatively. Thus the main discrepancy with experiments arises from the inadequate treatment in the fixed source theory, though a part of the yet remaining discrepancy might be explained by a modification of quantum electrodynamics as has been discussed by Yennie et al. (Abstr. 5857 of 1957).

539.12

11177 THE ELASTIC SCATTERING OF NEUTRONS IN CYLINDRICAL ABSORBERS. T.Kh.Sedelnikov.

J. nuclear Energy, Vol. 9, No. 1-4, 160-3 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 192 (1958).

Discusses, from a theoretical viewpoint, the scattering of neutrons in cylindrical absorbers. The total albedo for this situation and expressions for the neutron intensity emerging from a multiplying cylindrical element are obtained. R.H.Thomas

539.12

11178 ON THE SLOWING DOWN OF NEUTRONS IN AN HOMOGENEOUS INFINITE MEDIUM. V.C.Boffi.

Ann. Phys. (New York), Vol. 9, No. 3, 435-74 (March, 1960).

The object of the present paper is the study of the neutrons slowing down in an infinite homogeneous medium. The study is based on the discussion of the integral and differential equations obeyed by a characteristic differential quantity, i.e. the average number of collisions a neutron experiences in an infinitesimal interval of lethargy. The discussion is divided into three sections. The slowing down without capture is treated in Section I, where both the basic equations and the fundamental questions connected with the problem are discussed. The effects of constant capture are considered in Section II, where the moderating properties of different media will be compared. In Section III, the slowing down with varying capture and in particular the case of 1/v-capture is treated.

539.12

11179 NEUTRON FLUX DISTRIBUTIONS IN MEDIA SEPARATED BY A PLANE BOUNDARY. I.I.Talyanskii.

J. nuclear Energy, Vol. 9, No. 1-4, 105-7 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 372 (1958).

Expressions for the thermal neutron flux, using a two-group calculation, are given for the case of a point source of fast neutrons in a semi-infinite plane medium separated by a plane boundary from a different semi-infinite medium. J.F.Hill

539.12

11180 POLARIZATION OF 1.0 MeV NEUTRONS SCATTERED FROM DEUTERIUM.

S.E.Darden, C.A.Kelsey and T.R.Donoghue.
Nuclear Phys., Vol. 16, No. 2, 351-6 (May (1), 1960).

Neutron polarization produced in the scattering of 1 MeV neutrons by deuterons was measured. Asymmetry measurements were performed for c.m. scattering angles of 70°, 110° and 140° using the method of Levintov, Miller and Shamshev (Abstr. 9394 of 1957). The polarization was found to be small and opposite in sign to that predicted by Delves and Brown (Abstr. 8459 of 1959). An asymmetry measurement was also carried out at a c.m. scattering angle of 110° for 2 MeV neutrons.

539.12 : 539.17

11181 TIME-OF-FLIGHT MEASUREMENTS OF NEUTRON SPECTRA AT ENERGIES BELOW 0.5 MeV.

Yu.A.Vasilev, Yu.S.Zamyatnin, P.V.Toropov and E.F.Fomushkin.
J. nuclear Energy, Vol. 9, No. 1-4, 43-6 (June, 1959). English translation from: Atomnaya Energiya, Vol. 3, 542 (1957).

A time-of-flight spectrometer for neutrons with energies between 50 and 1000 keV is described. This was used to measure the spectrum of secondary neutrons resulting from the bombardment of U^{235} and U^{238} by 14 MeV neutrons from a pulsed DT source. The initial neutron pulse had a duration of 0.1 μ sec, the flight path was 6 metres and the detector was a multiple layer U^{235} fission counter. The overall energy resolution was about ± 15% for 100 keV neutrons. For layers of U^{235} and U^{238} of thickness of about one third of the mean free path for the incident neutrons, the secondary spectra agreed with the statistical distribution $Ee^{-E/T}$ above 200 keV energy. There was an excess of lower energy neutrons and this could be accounted for by multiple inelastic collisions or (n,3n) reactions. For a thicker U^{238} sample this low-energy excess was considerably greater. R.E.Meads

539.12

11182 HIGH-ENERGY NEUTRON BEAM OF 45% POLARIZATION. D.Miller and R.K.Hobbie.

Phys. Rev., Vol. 118, No. 5, 1391-6 (June 1, 1960).

A beam of polarized neutrons was produced by allowing the 164 MeV internal proton beam of the Harvard synchrocyclotron to strike a beryllium target. The neutrons produced in the forward direction were then polarized by scattering from carbon at 15°. When neutrons of energy greater than 110 MeV were selected by the detection process, an average beam energy of 124 MeV resulted. An intensity of 2.9×10^5 neutrons/in.^{2} min through a 2 in. by 6 in. collimator was obtained, with a polarization 0.447 ± 0.020. The shielding techniques are also discussed.

539.12

11183 SOME MONTECARLO EXPERIMENTS FOR THE STUDY OF A NEUTRON DETECTOR.

A.De Matteis and P.Giacobbe.
Energia nucleare, Vol. 7, No. 5, 350-7 (May, 1960).

A Monte Carlo procedure is described for evaluating some physical characteristics of a neutron detector. Three classical Monte Carlo techniques are described in some detail, i.e. the crude one and two others improved by using statistical weights. One of these latter techniques has been found to be the most efficient and it has been used for the calculations performed.

539.12

11184 ORGANIC SCINTILLANTS FOR PULSE SHAPE DISCRIMINATING NEUTRON COUNTERS.

H.O.Fungsten and G.C.Cobb.
Rev. sci. Instrum., Vol. 31, No. 5, 571-2 (May, 1960).

An attempt has been made to assess the relative differences in the slow components (~200 mμsec decay times) in several organic phosphors under 4 MeV D(d, n)He^3 neutron and 1.28 MeV Na^{22} gamma radiation. The application of the method to experiments involving the detection of fast neutrons in a background of gamma rays is discussed. S.J.St-Lorant

539.12

11185 EFFICIENT NEUTRON DETECTOR WITH A STABLE ENERGY THRESHOLD. D.Miller and R.K.Hobbie.

Rev. sci. Instrum., Vol. 31, No. 6, 621-3 (June, 1960).

The principle of a range telescope has been iterated to achieve a neutron detector with 2% efficiency at 125 MeV. The energy threshold is variable, yet its stability is high enough for precise asymmetry measurements. The logic of the counter introduces several economies in instrumentation.

539.12

11186 A PLANE-CRYSTAL AND BENT-CRYSTAL HIGH RESOLVING-POWER NEUTRON SPECTROMETER.

D.Bally, S.Todireanu, E.Tarină and I.Olteanu.
Rev. sci. Instrum., Vol. 31, No. 6, 640-6 (June, 1960).

The resolving function and the shape of the rocking curves are calculated for plane-crystal neutron spectrometers, taking into account the effect of total reflection from the collimator walk. The features of crystal-type neutron spectrometers are described for the plane-crystal and bent-crystal variants, and results obtained with such a spectrometer are presented. When using a calcite crystal, the resolving power of the instrument is 0.53μsec/m. In this case, the energy range extends up to 5.5 eV. Results obtained with a bent-quartz crystal are presented.

Mesons

539.12

11187 THE POSSIBLE EXISTENCE OF A NEUTRAL MESON WITH ISOTOPIC SPIN 0. Y.Yamaguchi.

Progr. theor. Phys., Vol. 19, No. 6, 622-30 (June, 1958).

The existence of this meson is suggested, and its effects on pion physics and some ways of testing its existence are discussed.

539.12

11188 QUESTION OF THE EXISTENCE OF STRANGENESS 2 MESON. D.J.Prowse.

Phys. Rev. Letters, Vol. 4 No. 5, 244-6 (March 1, 1960).

The experimental evidence given by Yamanouchi (Abstr. 2553 of 1960), in support of the existence of meson with strangeness 2 and mass 720 MeV, is discussed. It is shown in particular that the primary in the Bristol anomalous event is definitely a K meson, and a similar finding is reported for the Columbia event. The remaining evidence is shown to be open to other interpretations. A.Ashmore

539.12

11189 NUMERICAL DISCUSSIONS ON P-WAVE MESON—NUCLEON SCATTERING.

T.Sawaguri and J.Osada.
Progr. theor. Phys., Vol. 18, No. 1, 91-3 (July, 1957).

A discussion is given of meson—nucleon scattering in sixth order, considering only the terms which are included in the Chew—Low method. It is shown that crossing terms, which are neglected in the Tamm—Dancoff approximation, are not negligible. The three p-wave phase shifts are calculated at threshold and at a laboratory energy of 171 MeV. E.J.Squires

539.12

11190 ON THE LONGITUDINAL AND TRANSVERSE POLARIZATION OF POSITRONS IN μ^+-MESON DECAY.

S.Hori, H.Segawa and A.Wakasa.
Progr. theor. Phys., Vol. 19, No. 3, 249-56 (March, 1958).

The density matrix characterising the polarization state of positrons emitted from μ^+-meson decays at rest is calculated, using general parity non-conserving interactions, the mass of the electron being neglected. From the density matrix, the degree and direction of polarization of the positrons can be obtained. Detection of transverse polarization perpendicular to the plane defined by the polarization vector of the initial μ^+-meson and the propagation vector of the positron, will provide a test for the validity of invariance under Wigner's time reversal.

539.12

11191 POLARIZATION EFFECTS IN THE DIRECT TRANSITION OF $\mu^+ \mu^-$ INTO AN ELECTRON—POSITRON PAIR.

B.A.Lÿsov.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 571-2 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 404-5 (Feb., 1960).

Using a relativistic treatment, the probabilities of the $\mu^+ \mu^- \rightarrow e^+ e^-$ transition, through a virtual photon, are calculated for initial triplet and singlet spin states. In contrast with the non-relativistic calculations of Zel'dovich (Abstr. 9968 of 1959), the results predict different probabilities for the triplet case according to whether the spin component lies along or perpendicular to the direction of motion. Also, the electrons are emitted mainly in the direction of the spin component. In the non-relativistic limit the calculations agree with those of Zel' dovich. Both calculations predict zero probability for the singlet case. J.D.Dowell

539.12

11192

THE $\mu \to e + \gamma$ AND $\mu \to e + \nu + \bar{\nu} + \gamma$ DECAYS.

Yu.S.Krestnikov, A.G.Meshkovskii, Ya.Ya.Shalamov, V.A.Shebanov, and I.Yu.Kobzarev.

Zh. eksper. teor. Fiz., Vol. 37, No. 3, 873-5 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 622-4 (March, 1960).

A search for these decays was made in a 17 litre Freon bubble chamber. 91 000 $\pi^+ - \mu - e$ decays were observed but no example of $\mu \to e + \gamma$ was found. This upper limit for frequency agrees with counter experiments. 10 possible examples of $\mu \to e + \nu + \bar{\nu} + \gamma$ were found, in fair agreement with theory. E.J.Burge

539.12

11193

ON ELECTROMAGNETIC CORRECTIONS IN $\mu - e$ DECAY.

V.P.Kuznetsov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1102-5 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 784-6 (April, 1960).

Electromagnetic corrections to the electron angular distribution have been obtained for the V—A theory of $\mu - e$ decay.

539.12

11194

INTERACTIONS OF FAST μ MESONS IN LEAD WITH SMALL-ENERGY TRANSFER.

J.de Pagter and R.D.Sard.

Phys. Rev., Vol. 118, No. 5, 1353-63 (June 1, 1960).

With the Pb target material divided into 1.27 cm slabs between hodoscoped Geiger tubes and surmounted by a magnet cloud chamber, a study was made of the interactions of fast μ-mesons in which at least one evaporation neutron is produced and no additional charged particles emerge from the slab. The cross-section—average neutron multiplicity, $\sigma\bar{m}$, is $(15.2 \pm 2.1) \times 10^{-29}$ cm^2 per nucleon. From hodoscope observations without neutron coincidence it is found that for an electron-initiated shower to stay concealed in a 1.27 cm Pb plate its energy must be less than about 100 MeV. With the help of "approximation B" track length theory and experimental photonuclear neutron yields, it is calculated that hidden knock-on showers contribute $(5.8 \pm 1.2) \times 10^{-29}$ to the total yield $\sigma\bar{m}$ (cross-section times average multiplicity), leaving $(9.4 \pm 2.4) \times 10^{-29}$ cm^2 per nucleon as the result for the direct μ-meson nuclear interaction. This analysis is supported by the agreement between the number of visible showers observed and calculated. The neutron yield in the direct interaction is found to increase with μ-meson momentum. The Weizsäcker—Williams approximation is used to calculate the effect expected from the interaction between electric charge of the μ-meson and the nucleons. Within the rather large uncertainties involved in the use of this approximation, there is excellent agreement with the experimental results.

539.12

11195

MESON CAPTURE IN He^3.

C.Werntz.

Nuclear Phys., Vol. 16, No. 1, 59-71 (April, 1960).

The effective Hamiltonian of Fujii and Primakoff (Abstr. 8472 of 1959; 366 of 1960) is used to calculate the capture rate $\omega(\mu)$ of μ^- mesons by He^3 leading to the bound state of H^3. The ground state of the three-body nucleus is taken to be a state with total angular momentum $\frac{1}{2}$ and isobaric spin $\frac{1}{2}$ with a small D-state admixture to the predominant S-state. The dependence of the capture rate on the percentage of D-state admixture and on the r.m.s. radius of the nucleus is found. A calculation of the r.m.s. radius using S-state wave functions derived from hard core potentials leads to values of $\omega(\mu)$ 7% to 10% higher than that calculated by Fujii and Primakoff.

539.12

11196

CAPTURE OF POLARIZED μ^--MESONS BY DEUTERONS.

A.P.Bukhvostov and I.M.Shmushkevich.

Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1471-3 (Nov., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 5, 1402-3 (May, 1960).

Because of the relatively long life of the μ-meson, there is an appreciable probability for the nucleus to also become polarized, through the hyperfine-structure interaction (Abstr. 8682 of 1959), before the capture of the μ-meson from the K-orbit. Formulae are therefore presented for the capture processes both for the doublet and quadruplet hyperfine states. P.K.Kabir

539.12

11197

A POSSIBLE METHOD FOR THE DETERMINATION OF THE DIRECTION OF POLARIZATION OF μ^--MESONS.

V.A.Dzhrbashyan.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1572 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1115-16 (Nov., 1959).

An expression is given for the angular distribution of the circularly polarized γ-rays emitted when a μ^--meson undergoes a transition from one level to another, and in particular the 2p—1s transition. E.J.Burge

539.12

11198

DEPOLARIZATION OF μ^+ MESONS IN NUCLEAR EMULSION.

A.O.Vaisenberg, N.V.Rabin and V.A.Smirnit-skii.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1680-6 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1197-201 (Dec., 1959).

Measurements were made of the asymmetry coefficient for π^+-μ^+-e^+ decay in ordinary and diluted NIKFI-R emulsion, and in the same emulsion placed in a strong magnetic field. An analysis of the data obtained and that known from the literature shows that the asymmetry coefficient in NIKFI-R emulsion ($a = -0.077 \pm 0.012$) is substantially less than that in Ilford G-5 emulsion ($a = -0.139 \pm 0.014$). A double dilution of the NIKFI-R emulsion with gelatin sharply increases the asymmetry coefficient ($a = -0.127 \pm 0.028$). The application of a magnetic field restores the polarization in the NIKFI-R emulsion, raising the asymmetry coefficient to a value $a = -0.28 \pm 0.02$ in a field of 17 000 G.

539.12

11199

THE MANY π-MESON PROBLEM.

A.Pais.

Ann. Phys. (New York), Vol. 9, No. 4, 548-602 (April, 1960).

It is shown that the properties of a system of N π-mesons are to a considerable extent determined by three quantum numbers (N_1,N_2,N_3), the "correlation numbers", whose sum equals N. In a state with definite correlation (specific values of N_1,N_2,N_3) these numbers relate to the number of triples: 3π-subsystems with I = 0; the number of pairs: 2π systems with I = 1 and the remaining singles out of which such a state can be composed by a well-defined prescription. For states with definite correlation, the correlation numbers dictate which I-spin values such states can possibly have. For systems with $I < 2$ ("N π-clouds") the correlation numbers determine the I-spin uniquely. The branching ratios for an N π-cloud into the various charge distributions compatible with given N and total charge are not uniquely determined if one only gives the I-spin of a specific state. However, it is shown that one gets unique results if one is only given the correlation numbers. General methods are developed for determining these ratios as functions of N_1,N_2,N_3. Tables are given for these ratios for N = 2-8. In Section II all results are compiled and rules are given for practical use. All mathematical proofs are found in Section IV. It is shown there that the present results can all be obtained without recourse to the explicit use of vector addition coefficients. The basic tools are Young's (nonorthogonal) representations of the symmetric group and Thrall's theorem on its orthonormal idempotents. Applications to annihilation processes are discussed (Section III) with special reference to p-p and p-d annihilation. Zero- and two-prong star theorems are given. A statistical model for p-p and p-n-annihilation predicts that, with increasing N, the ratio of the average number of charged π's to the average number of neutral π's produced in N π-annihilation becomes nearly equal to 2. However, the predominance of specific correlations could lead to substantially different values for this ratio. The connection between charge correlations and spatial correlations as well as some dynamical aspects of the problem are briefly discussed in Section V.

539.12

11200

POLARIZATION EFFECTS IN THE $\pi^0 \to e^- + e^+ + \gamma$ DECAY.

B.K.Kerimov, A.I.Mukhtarov and S.A.Gadzhiev.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 575-6 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 407-8 (Feb., 1960).

The probability of this decay is calculated for arbitrary polarizations of the final particles. E.J.Squires

539.12

11201 THE PION–NUCLEON COUPLING CONSTANT.
T.D.Spearman.

Nuclear Phys., Vol. 16, No. 3, 402-4 (May (2), 1960).

Using the sum rule obtained by taking the limit of infinite energy in the π–p forward scattering dispersion relation, a value for the renormalized coupling constant $f^2 = 0.078 \pm 0.008$ is obtained, which is in good agreement with the values obtained from other methods.

is obtained, which is in good agreement with the values obtained from other methods.

539.12

11202 AN ATTEMPT AT REFORMULATING PION–NUCLEON INTERACTION. I. INTRODUCTION OF K-SPACE.
O.Hara, Y.Fujii and Y.Ohnuki.

Progr. theor. Phys., Vol. 19, No. 2, 129-145 (Feb., 1958).

The reformulation is attempted with a view to providing a better understanding of the large annihilation cross-section of the anti-proton, and of the results of the high-energy scattering of electrons by nucleons and deuterons. For this purpose, the concept of K-space is introduced. In terms of K-space, charge conjugation can be expressed as a rotation through π around its second axis multiplied by a rotation through π around the second axis in the usual isotopic space. It is shown that if the pion–nucleon interaction is assumed invariant under rotations in K-space (it is already invariant under rotations in the usual isotopic space if one assumes charge independence), it cannot be local, especially the part responsible for the creation and the annihilation of nucleon pairs. Possibilities of checking this assumption experimentally are discussed, and among these the annihilation of antinucleons by nucleons is discussed in some detail.

539.12

11203 AN ATTEMPT AT REFORMULATING PION–NUCLEON INTERACTION. II. SCATTERING OF ANTIPROTON BY NUCLEON.
O.Hara and Y.Fujii.

Progr. theor. Phys., Vol. 20, No. 1, 89-107 (July, 1958).

The scattering of antiprotons by nucleons is calculated assuming "nucleonic charge independence", in which nucleon and antinucleon are assumed to correspond to the third component of an angular momentum in the charge space and its conservation is assumed. It is shown that according to this assumption, the elastic and the charge exchange parts of the antinucleon–nucleon scattering are related to the nucleon–nucleon scattering in a simple way, just as neutron–proton scattering is related to proton–proton scattering by charge independence. Explicit results are given for the total cross-sections and the angular distributions of the elastic and the charge exchange parts of ($\bar{p}p$) scattering and for the elastic part of ($\bar{p}n$) scattering. As far as comparison with experiment is possible, the result predicted by the theory is not unreasonable.

539.12

11204 ON THE HEAVY MESON PRODUCTION IN THE π^-–PROTON REACTION.
T.Ogimoto and T.Shimizu.

Progr. theor. Phys., Vol. 18, No. 2, 213-14 (Aug., 1957).

The angular distributions of heavy mesons produced by the π^-–proton reaction are examined by means of the lowest order perturbation theory. The conclusions are compared with existing experimental results. C.F.Barnaby

539.12

11205 π^-–p INTERACTION IN HIGH ENERGY REGION.
D.Ito, T.Kobayashi, M.Yamazaki and S.Minami.

Progr. theor. Phys., Vol. 18, No. 3, 264-8 (Sept., 1957).

It is shown that the elastic and total cross-sections for π^-–p collisions above 1.0 BeV can almost be explained as the shadow effect of the inelastic collision. From this result, a discussion is given as to whether or not the second maximum of the total cross-section for this reaction can be interpreted in terms of inelastic scattering.

539.12

11206 $\pi^{\pm}$–p TOTAL CROSS-SECTIONS IN THE RANGE 450 MeV TO 1650 MeV.
T.J.Devlin, B.C.Barish, W.N.Hess, V.Perez-Mendez and J.Solomon.

Phys. Rev. Letters, Vol. 4, No. 5, 242-4 (March 1, 1960).

The arrangement for defining the incident pion momentum, focusing the beam and eliminating protons is described. Total cross-sections were measured by transmission through liquid hydrogen using six counters defining solid angles between 1.5 and 7.1 milli-steradians. Extrapolation to 0° was thus made. Peaks are observed in the π^- cross-section at 600 ± 15 and 900 ± 15 MeV, and in the π^+ cross-section at about 1350 MeV. A.Ashmore

539.12

11207 PUPPI–STANGHELLINI DISCREPANCY.
H.P.Noyes and D.N.Edwards.

Phys. Rev., Vol. 118, No. 5, 1409-16 (June 1, 1960).

As was first noted by Puppi and Stanghellini (Abstr. 8408 of 1957), the pion–nucleon forward-scattering-amplitude dispersion relations (Abstr. 8509 of 1955) are in apparent disagreement with experiment. In order to establish the extent of this disagreement in a statistical sense, the uncertainty in the dispersion integrals and S-wave scattering lengths is systematically included in the analysis. To accomplish this, the authors fit the total cross-sections below 335 MeV by a Chew–Low P-wave resonance, phenomenologically modified, and calculate the error matrix for the parameters. The fit to the total cross-sections is statistically at least as good as the Anderson parameterization used in previous work. Ignoring forward scattering amplitudes above 220 MeV because of D-wave uncertainties, it is still found that there is less than a 4½% probability that the published data are compatible with a unique value for the pion–nucleon coupling constant f^2, and that no adjustment of the S-wave scattering lengths can remove the discrepancy. However, if the π^- forward-scattering amplitudes measured by Ashkin et al. at 150 and 170 MeV are abandoned in favour of the values recently obtained by Kruse and Arnold at 130 and 152 MeV, the probability rises to 47.2% for the authors' parameterization, or 8.6% for the Anderson parameterization. Cini et al. have pointed out that the conventional analysis of the low-energy data to obtain the S-wave scattering length does not satisfy crossing symmetry, and a re-analysis by Hamilton and Woolcock gives $a_+ = -0.083$, $a_- = 0.088$, rather than the conventional values of −0.110 and 0.077. Some independent evidence in support of this conclusion is obtained by using the dispersion relations to determine a_+, a_-, and f^2 simultaneously. It is found:

Energy dependence	f^2	a_+	a_-
Anderson	0.075 ± 0.018	−0.086 ± 0.025	0.071 ± 0.020
Modified Chew–Low	0.086 ± 0.019	−0.101 ± 0.026	0.085 ± 0.020

It is clear that a better theoretical description of the energy dependence of the total cross-sections will be required before further progress can be made on this problem.

539.12

11208 MESONS AND THE STRUCTURE OF NUCLEONS. III. PION–NUCLEON SCATTERING.
G.Costa and B.T.Feld.

Ann. Phys. (New York), Vol. 9, No. 3, 354-72 (March, 1960).

For Pt II, see Abstr. 7257 of 1958. The "atomic" model of the physical nucleons was used in a direct computation of the scattering of free pions by nucleons. The computation is analogous to the computation of the scattering of electrons by hydrogen atoms. Neglectin any pion–pion interaction, p-wave scattering phase-shifts are comp in the Born approximation and also by an improved technique, for various assumptions concerning the interaction between a pion and the nucleon "core". The model is shown to be capable of reproducin the resonant scattering in the (3,3) isobar state, while predicting mu smaller phase shifts for the other states. The results obtained diffe from the Chew–Low theory, in the Born approximation, only in that here a small, positive phase-shift for scattering in the (1,1) state is predicted; the experiments appear to favour the present author's prediction. It is concluded that the same pion–nucleon interaction, which accounts for the properties of the ground (physical) nucleon state, leads to the observed low-energy pion–nucleon scattering.

539.1

11209 PION–NUCLEON SCATTERING AND THE STRUCTURE OF THE PION.
S.Machida.

Progr. theor. Phys., Vol. 18, No. 5, 467-82 (Nov., 1957).

Effects of the structure of the pion on pion–nucleon scattering are discussed. A formal expression of the interaction kernel for the nucleon–antinucleon propagator is given, from which the "effective Hamiltonian" for the emission and absorption of one pion and that for two pions are derived respectively. Effects of two pion vertex, which is characteristic of the structure of the pion, seen to be not necessarily negligible compared with the effects of one pion vertex, according to a very rough estimate of the order of magnitude of the "coupling constant" appearing in the interaction kernel for the nucleon–antinucleon propagator. At present two standpoints are recognized with respect to the theory of the pion, i.e. the compound theory of the pion and the conventional local pion field theory. Some important properties of both theories are discussed using the above method, and qualitative properties are obtained concerning the isospin dependence of the pion—nucleon scattering matrix elements. Quantitative evaluation of the possible effects are not made, since for that purpose it is necessary to study the details of the structure of the pion. Such an attempt is not made in the present paper. It is shown that the crossing symmetry for the pion—nucleon scattering holds even if the pion is considered to be composed of arbitrary number of fermion pairs and bosons, provided that the primary interaction Lagrangian satisfies the integrability condition to assure the existence of propagators.

539.12

11210 POLARIZATION OF RECOIL PROTONS IN π^-—p SCATTERING AT 300 MeV.

I.M.Vasilevskii and V.M.Vishnyakov.
Zh. eksper. teor. Fiz., Vol. 38, No. 5, 1644-6 (May, 1960). In Russian.

Preliminary results based on 305 events are presented. The measurements at three angles for the outgoing pion are consistent with a Fermi, but not a Yang, set of phase shifts. D.W.L.Sprung

539.12

11211 THE POSSIBILITY OF DETERMINING THE π—π SCATTERING AMPLITUDES FROM THE ANALYSIS OF THE $\gamma + p \rightarrow N + \pi + \pi$ REACTIONS NEAR THRESHOLD.

A.A.Ansel'm and V.N.Gribov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1890-3 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1345-7 (Dec., 1959).

It is shown that a study of the reactions $\gamma + p \rightarrow p + \pi^+ + \pi^-$, $p + \pi^0 + \pi^0$, $n + \pi^+ + \pi^0$ near threshold should allow the determination of the π—π zero energy scattering amplitudes if the π—π interaction has a resonance character, and the determination of a certain combination of these amplitudes if the interaction does not have a resonance character.

539.12

11212 RESONANCE INTERACTIONS OF PIONS.

V.S.Barashenkov and V.M.Mal'tsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 884-6 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 630-1 (March, 1960).

The hypothesis of resonance interaction between mesons is shown to be unnecessary to explain the experimental data on inelastic π^-—p collisions at 5 GeV. E.J.Burge

539.12

11213 PION PRODUCTION BY PIONS.

W.A.Perkins,III, J.C.Caris, R.W.Kenney and V.Perez-Mendez.
Phys. Rev., Vol. 118, No. 5, 1364-70 (June 1, 1960).

A liquid hydrogen target was bombarded by negative pions of energies 260, 317, 371, and 427 MeV. Positive pions from the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ were detected by the use of a counter telescope that selected the π^+ by its characteristic π—μ decay. With the 260 MeV beam, π^+-mesons were counted at 90° in the laboratory system. At 317, 371, and 427 MeV, the differential cross-section was measured for π^+-mesons emitted at 60°, 90°, 125°, and 160° in the centre-of-mass system. The angular distributions are nearly isotropic at 317 and 371 MeV but are peaked forward at 427 MeV. The total cross-sections are 0.14 ± 0.10 mb at 260 MeV, 0.71 ± 0.17 mb at 317 MeV, 1.93 ± 0.37 mb at 371 MeV, and 3.36 ± 0.74 mb at 427 MeV. These results indicate a much larger cross-section than the theoretical prediction based on the static model. Reasonable agreement can be obtained by the inclusion of a pion—pion interaction in the production mechanism.

539.12

11214 THE PRODUCTION OF π^--MESONS IN THE PION—NEUTRON COLLISION AT 1.2 GeV.

L.Bertanza, P.Franzini, I.Mannelli, G.V.Silvestrini and P.H.Stoker.
Ricerca sci., Vol. 29, No. 9, 1971-3 (Sept., 1959). In Italian.

Results from an analysis of a film obtained with a propane bubble chamber exposed to the 1.2 GeV π^--beam from the Brookhaven cosmotron. By comparing the results with the theoretical distributions deduced from a statistical theory and from an isobar model theory, there seems to be an indication that at this energy the pion—neutron interaction proceed mainly through the real excitation of the isobaric state 3/2, 3/2. The momentum distribution of the bound neutrons in carbon has been taken into account. G.Martelli

539.12

11215 NUMERICAL SOLUTION OF THE STATIC DISPERSION RELATIONS OF THE [PION] PHOTOPRODUCTION P-WAVE.

L.D.Solov'ev and G.N.Tentyukova.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 889-90 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37, No. 3, 634-5 (March, 1960).

An exact numerical solution of the regular Fredholm equations for pion photoproduction was obtained. The authors find that the agreement with experiment is improved near threshold. W.A.Hepner

539.12

11216 APPLICATION OF DISPERSION RELATIONS TO K_{e3} AND $K_{\mu 3}$ DECAYS.

R.F.Sawyer.
Phys. Rev., Vol. 118, No. 2, 618-22 (April 15, 1960).

The decay modes, K_{e3} and $K_{\mu 3}$, are studied by means of a dispersion relation. It is assumed that the fundamental couplings involved are the strong pion and K-meson couplings to the baryons and a weak four-field coupling connecting nucleon, hyperon, and the lepton pair. The baryon—antibaryon pair contribution to the absorptive part of the decay amplitude is expressed in terms of the imaginary part of the pion propagator in the same approximation. The decay rate is determined in terms of the various coupling constants and the quantity Z which renormalizes the pion propagator. Comparison with experiment is made for the case $g_\pi^2/g_k^2 = 15$. The results are consistent with a hyperon leptonic decay coupling constant an order of magnitude less than the beta-decay strength.

539.12

11217 INVARIANTS IN $K_{\mu 3}$ AND K_{e3} DECAYS.

R.Gatto.
Progr. theor. Phys., Vol. 19, No. 2, 146-52 (Feb., 1958).

The decay modes are discussed, making use of the invariance properties of the theory, under the general hypothesis of parity nonconservation and lepton nonconservation. The assumption of local interaction between the final fermions is examined in detail. Detection of a possible up-down asymmetry, with respect to the $K_{\mu 3}$ decay plane, of the electrons from the subsequent μ decay is suggested as a possible test of time reversal.

539.12

11218 THE K_{e3} AND $K_{\mu 3}$ DECAYS.

S.G.Matinyan and L.B.Okun'.
Zh. eksper. teor. Fiz. Vol. 36, No. 4, 1317-19 (April, 1959). In Russian. English translation: in Soviet Physics--JETP (New York), Vol. 36(9), No. 4, 933-4 (Oct., 1959).

The decay of K_{e3} and $K_{\mu 3}$ mesons is considered for an interaction of the universal A—V type. Information which could be obtained from a measurement of the longitudinal polarization of the μ-meson is discussed. C.J.Batty

539.12

11219 ANALYSIS OF THE EXPERIMENTAL τ^+ DECAY SPECTRUM AS A TEST OF THE $\Delta T = \frac{1}{2}$ RULE.

S.Bjorkland, E.L.Koller and S.Taylor.
Phys. Rev. Letters, Vol. 4, No. 8, 424-5 (April 15, 1960).

The experimental energy spectrum of the odd pion in the three-pion decay of positive K mesons is compared with the form of the spectrum predicted by Weinberg on the basis of the $\Delta T = \frac{1}{2}$ isotopic spin selection rule. The data are consistent with the theory. D.J.Thouless

539.12

11220 REGENERATION AND MASS DIFFERENCE OF NEUTRAL K MESONS.

F.Muller, R.W.Birge, W.B.Fowler, R.H.Good, W.Hirsch, R.P.Matsen, L.Oswald, W.M.Powell, H.S.White and O.Piccioni.
Phys. Rev. Letters, Vol. 4, No. 8, 418-21 (April 15, 1960).

Experimental results are given for the angular distribution of neutral K1 mesons produced near the forward direction by a beam of K2 mesons traversing a plate. Three processes, distinguished by their angular distribution, contribute to the production of these K1 mesons. These are the transmission regeneration, in the forward direction only, the diffraction regeneration, sharply peaked forward, and the incoherent regeneration by individual nucleons, which has a much broader peak. An expression for the ratio of the first two, depending on the mass difference and the K1 lifetime (τ_1), is obtained. If the background, due mainly to the third process, is ignored the mass difference is found to be $0.85\ \hbar/\tau_1$, with an error of about $\pm 0.3\ \hbar/\tau_1$. The effect of the background reduces this value.

E.J.Squires

539.12

11221 ELECTROMAGNETIC MASS OF THE K MESON.

Chzhou Guan-chzhao [Chou Kuang-Chao] and V.I.Ogievetskii.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 866-7 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 616-17 (March, 1960).

An expression for the electromagnetic self-mass of the K-mesons in terms of form factors is used to show that the mass difference between K^+ and K^0 could be of purely electromagnetic origin.

J.Goldstone

539.12

11222 SYMMETRIES IN STRONG INTERACTIONS AND THE $KK\pi\pi$-INTERACTION.

Ning Hu.

Science Record (China), New Series, Vol. 3, No. 12, 616-22 (Dec. 1959).

Pais has shown (Abstr. 3704 of 1958) that the assumption of symmetric interaction of K-mesons with baryons, similar to that postulated for pion interactions, leads to contradiction with experiment. A theory [Nuclear Phys., Vol. 8, 85 (1958)] recently proposed by the author suffers from the same difficulty. It is here shown that the introduction of a $KK\pi\pi$-interaction removes the objection and arguments are presented in favour of this hypothesis.

P.K.Kabir

539.12

11223 THE TRANSFORMATION $K_2^0 \to K_1^0$ BY ELECTRONS.

Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1381-6 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 984-7 (Nov., 1959).

The E0 transformation of K_2^0 to K_1^0 by their interaction with electrons is examined. An estimate is given of the cross-section for the process and its angular distribution. The interference of the electron and nuclear interactions in the transformation of K_2^0 to K_1^0 in the unscattered beam is considered.

539.12

11224 ANALYSIS OF THE SCATTERING OF K^+ MESONS IN EMULSION.

L.S.Rodberg and R.M.Thaler.

Phys. Rev. Letters, Vol. 4, No. 7, 372-5 (April 1, 1960).

Using data from the scattering of K^+-mesons in emulsion and by hydrogen ($T = 1$) at energies less than 350 MeV, an analysis was carried out of the K^+—nucleon interaction in the $T = 0$ state, in terms of a complex square-well potential. The $T = 1$ interaction, for the energy range considered, is assumed to occur only in the s-state, and the $T = 0$ interaction only in s and p states. Although rough values for the s-wave phase-shift and well depth are determined, the results for p-waves are inconclusive because of uncertainties in the experimental results.

J.D.Dowell

539.12

11225 DISPERSION RELATION FOR THE PHOTOPRODUCTION OF K-MESONS.

S.Okubo.

Progr. theor. Phys., Vol. 19, No. 1, 43-56 (Jan., 1958).

Dispersion relations for the photoproduction of K-mesons on nucleons are derived both covariantly and non-covariantly. They contain the renormalized Born term with inclusion of the magnetic moments of baryons.

Hyperons

539.12

11226 THE MECHANISM OF THE LEPTONIC DECAY OF HYPERONS.

V.V.Turovtsev.

Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1326-7 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 939-40 (Oct., 1959).

The ratio of the decay rates into muons and electrons, via a virtual spin zero K-meson, is considered according to the two versions corresponding to a four-field interaction of S and P on the one hand, and V—A on the other.

W.A.Hepner

539.12

11227 FORM-FACTOR AND PROBABILITY OF LEPTONIC DECAY OF Λ-PARTICLES.

Khe Tszo-syu [Ho Tso-Hsiu].

Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1825-7 (Dec., 1959). In Russian.

Expressions are given for the leptonic decay rates, taking into account the influence of the strong interactions through the introduction of form-factors.

P.K.Kabir

539.12

11228 MASS DIFFERENCES OF Σ^+, Σ^- AND Σ^0 HYPERONS.

H.Katsumori.

Progr. theor. Phys., Vol. 17, No. 6, 803-6 (June, 1957).

It is shown that it is possible to interpret the observed mass differences of Σ^+, Σ^- and Σ^0 hyperons in terms of electromagnetic self-energies, if the Σ hyperons are assumed to be Dirac particles with anomalous magnetic moments of a few nuclear magnetons. Comparisons are made with the work of Sudarshan and Marshak (Abstr. 2693 of 1957).

539.12

11229 ANOMALOUS MAGNETIC MOMENTS OF HYPERONS AND MIRROR THEOREM.

H.Katsumori.

Progr. theor. Phys., Vol. 18, No. 4, 375-82 (Oct., 1957).

Using the theory of d'Espagnat and Prentki (Abstr. 2668 of 1956) the anomalous magnetic moments of hyperons are calculated in the lowest order perturbation approximation. It is further shown that their charge-independent interaction Hamiltonian leads to the mirror theorem for the anomalous magnetic moments of baryons (and of K-mesons) without use of perturbation approximation. Finally, the anomalous magnetic moments of Σ-hyperons determined from the mass differences of Σ and the mirror theorem are compared with the perturbation results.

Strange particles

539.12

11230 SOME REMARKS ON THE GOLDHABER MODEL FOR STRANGE PARTICLES.

R.Kawabe.

Progr. theor. Phys., Vol. 18, No. 1, 96-7 (July, 1957).

It is suggested that if Λ^0 and Σ^0 particles can be regarded as bound states of the $\overline{K}$—nucleon system, in which the $\overline{K}$ retains the essential features of its free particle behaviour, then a Pais—Piccioni type effect should occur due to different lifetimes of the $\overline{K}^0$ and K^- mesons. An approximate expression is obtained for the relative intensity of Λ^0 to Σ^0 particles as a function of time.

E.J.Squires

539.12

11231 ON THE DECAY INTERACTION OF STRANGE PARTICLES.

B.Sakita and S.Oneda.

Nuclear Phys., Vol. 16, No. 1, 72-80 (April, 1960).

It is proposed that the strength of the coupling constants is different for the strangeness non-conserving and strangeness conserving currents in the scheme of Fermi interactions of an ordinary charged current-current type. First, the consistency with experimental results is analysed by introducing phenomenologically the direct $\overline{\Lambda}n$ interaction. Then, the possibility of the derivation of this interaction as the effective interaction of the primary Fermi interactions is discussed.

539.1

11232 ON THE DECAY INTERACTIONS OF STRANGE PARTICLES.

Y.Miyachi.

Progr. theor. Phys., Vol. 19, No. 1, 112-24 (Jan., 1958).

Under the assumption that the Konopinski—Uhlenbeck interaction (1935) operates as the origin of weak interactions in which the existence of strange particles should be taken into account, the decay events $K_{\mu 3}^{\pm}$, $K_{e3}^{\pm}$, $K_{\mu 3}^{0}$ and K_{e3}^{0} are investigated. The available data seem to favour these predictions, though it is premature to draw any definite conclusions. Some remarks are also made about β-decay of hyperons and the K-meson decay into two leptons.

539.12

11233 ISOTOPIC SPIN AND STRANGE PARTICLES.

G.Takeda.

Progr. theor. Phys., Vol. 19, No. 6, 631-45 (June, 1958).

Studies of the isotopic spin change in various strange particle ecays and of the conservation of the isotopic spin in the strong nteractions have led to the introduction of a new and independent pace (i'-space) in addition to the i-space. The i'-spin quantum umber of baryons and heavy mesons, the property of the π and K ouplings in the i'-space as well as in the i-space, and the decay election rules of strange particles are determined in a rather unique ashion. Semi-quantitative comparison is made between experiment nd the predictions of the theory, and similarities with the work of 'Espagnat et al. (Abstr. 5624 of 1958) are noted.

539.12

11234 NONCONSERVATION OF PARITY IN STRONG INTERACTIONS BETWEEN STRANGE PARTICLES.

.G.Matinyan.

h. eksper.teor. Fiz., Vol. 37, No. 4(10), 1034-40 (Oct., 1959). In ussian. English translation in: Soviet Physics — JETP (New ork), Vol. 37(10), No. 4, 736-40 (April, 1960).

A modification of Lee and Yang's theory of strange-particle arity doublets is considered in which parity conjugation invariance s extended to weak interactions. As a result, nonconservation of arity in weak interactions is found to be closely related to a change n strangeness. Results of the analysis pertaining to the "forward-ackward" asymmetry of the hyperon decay products are compared ith the corresponding consequences due to nonconservation of parity n strange particle creation and interaction processes. Both interpre-ations are found to yield the same results as long as particles with dd-strangeness are concerned. The two approaches can be distin-uished by studying processes involving Σ-hyperons.

539.12

11235 PARITY-NONCONSERVATION AND THE SPINS OF THE STRANGE PARTICLES. K.Itabashi.

Progr. theor. Phys., Vol. 19, No. 4, 359-68 (April, 1958).

Taking into account the possible nonconservation of parity in eak interactions, the decay angular distributions of the strange articles produced by pion—nucleon collisions are re-examined. It s shown that, when the parity-nonconservation effect is actually ob-erved in the decay angular distribution of the hyperon, its spin alue can be determined less ambiguously than in the case of the arity-conservation. Especially, in this case, it is possible in rinciple to decide completely whether the spin is 1/2 or not. The ffect of the parity-nonconservation can appear also in the $K_{\mu 2}$ nd $K_{\pi 3}$ modes of decay, unless the spin of K is zero. Taking this nto account, the possibility of determining the spin of the K-meson s also considered. In this case, however, the conclusion is not so ecisive as the case of the hyperon.

Deuterons

539.12

11236 MAGNETIC DIPOLE SUM RULES FOR PHOTODISINTEGRATION OF THE DEUTERON.

M.L.Rustgi and J.S.Levinger.

Progr. theor. Phys., Vol. 18, No. 1, 100-1 (July, 1957).

An expression for the bremsstrahlung weighted cross-section or magnetic dipole photodisintegration of the deuteron, previously btained on the basis of the effective range approximation, is shown o be true more generally. An expression is also obtained for the otal magnetic dipole transition rate as a function of the parameters iving the exchange mixture of the assumed nuclear potential.

E.J.Squires

539.12

11237 COMPLETE DETERMINATION OF POLARIZATION FOR A HIGH-ENERGY DEUTERON BEAM.

.Button and R.Mermod.

Phys. Rev., Vol. 118, No. 5, 1333-44 (June 1, 1960).

Double-scattering measurements were made which yielded all arameters necessary to describe completely the interaction of the euteron with complex nuclei. Deuterons of 410 and 420 MeV were cattered from beryllium and carbon, respectively. Tensor com-onents of polarization, which should appear in the scattering of pin-1 particles and which were unobservable at low energies, were etermined to be appreciably different from zero. The usual vector pin polarization normal to the plane of scattering was found to reach maximum of about 70%. The impulse approximation was employed o obtain estimates of deuteron cross-section and polarization on he basis of nucleon scattering data.

Tritons

539.12

11238 KINETIC AND POTENTIAL ENERGY MATRIX ELEMENTS FOR THE TRITON. G.H.Derrick.

Nuclear Phys., Vol. 16, No. 3, 405-22 (May (2), 1960).

The matrix elements of the kinetic energy operator and of the common potential energy operators are calculated for the total angular momentum and isobaric spin functions of the triton. The conditions necessary for the convergence of the kinetic energy integrals are investigated.

539.12

11239 LOW-ENERGY PHOTODISINTEGRATION OF H^3 AND He^3 AND NEUTRON—DEUTERON SCATTERING.

L.M.Delves.

Phys. Rev., Vol. 118, No. 5, 1318-22 (June 1, 1960).

The cross-sections for electric dipole photodisintegration of H^3 and He^3 at low energies are expressed in terms of the effective range parameters of the doublet n—d scattering matrix. Agreement with the experimental results is possible for either set of n—d scattering lengths.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

537.59

11240 MEASUREMENT OF THE ABSORPTION LENGTH AND COLLISION MEAN FREE PATH OF PENETRATING SHOWER PRODUCING COSMIC RAY PARTICLES IN LEAD.

G.Bozóki, E.Fenyves and L.Jánossy.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 170-3.

The absorption length of penetrating shower producing particles was measured in lead under absorber thicknesses from 450 to 900 g cm^{-2} by means of a penetrating shower detector. In order to select single nuclear active particles local penetrating showers were detected and the coincidence rates measured were corrected for spurious effects. The absorption length was found to be 414 ± 17 g cm^{-2}, in good agreement with the results of other experiments. The mean energy of recorded penetrating shower particles was estimated from their rates to be between 30 and 60 GeV. Measurements on the collision mean free path of penetrating shower producing neutrons in lead are going on with the same penetrating arrangement. The preliminary value of the collision mean free path of neutrons having mean energies of about 30 GeV is estimated to be 223 ± 19 g cm^{-2} which is significantly greater than the geometrical collision mean free path and agrees well with accelerator data obtained at several GeV.

537.59

11241 DESIGN AND PRELIMINARY RESULTS OF AN AIR SHOWER EXPERIMENT. K.Sitte, G.Davies, H.Kasha, N.Lerman, Y.Oren, A.Shapiro, I.Segal and D.Stern.

Cosmic Ray Conference, Moscow, 1959 English Edition (see Abstr. 7427 of 1960) Vol. II, p. 44-9.

Describes an experiment, designed to study two problems: (1) The lateral distribution of Cherenkov pulses as a function of shower size, and (2) The interaction mean free path of the shower primaries. The first subject was chosen with a view on the possibility of using, at a later stage, microwave techniques, the efficiency of which for showers of primary energies above $\sim 10^{17}$ eV has been demonstrated by improved calculations. The present experiment uses two Cherenkov light detectors in conjunction with an 8-tray hodoscope. The second subject requires classification of showers according to age, size, and zenith angle. Age determination is achieved by measuring the energy of the nucleonic component near the core, and by recording the μ-meson/electron ratio. Shower sizes are measured by the counter hodoscope already mentioned, and the zenith angle classification is carried out by a direction-sensitive core detector consisting of a flat Cherenkov counter viewed by eight horizontally mounted photomultipliers, and a lead-covered scintillation counter placed underneath. In a preliminary experiment, the geomagnetic asymmetry of the showers was measured at average distances of 7 m and 14 m from the core. No statistically significant difference between the two values was found, but the combined results of an ellipticity of (11.5 ± 5.5)% is much higher than the value expected for electrons. For the μ-meson component, the asymmetry was (10 ± 4)%.

537.59

11242 SMALL AIR SHOWERS AT SEA LEVEL.

R.D.Doolittle, III and W.E.Hasen.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 69.

Brief note, substantially as follows. An array of 27 ion chambers was used for a survey of showers at sea level, in order to determine the design of a more detailed study of the core of air showers. The axes of eleven showers struck the central area of 0.85 m^2 of the array for which the average trigger probability was 0.88. The absolute intensity was 4.2 (±1.2) × 10^{-6} m^{-2} sec^{-1}. Using the Nishimura—Kamata lateral distributions, it was found that the minimum shower size was about 3 × 10^4 electrons. This absolute intensity agrees with the intensities deduced from GM counter measurements. Eighteen axes struck within the central array where their lateral distributions could be observed. In 16 cases only one core was observed. One event had two observed cores separated by one or two metres. One event contained three observed cores separated by 2 to 3 metres.

537.59

11243 THE ABSORPTION OF AIR SHOWERS.

J.Malos.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 84.

Brief note, substantially as follows. The zenith angles of showers were determined in the Sydney Air Shower Experiment by a fast timing method. The absorption length of showers was determined from this after applying various corrections and found to be:

$$\Lambda_1 = 125^{+19}_{-17} \text{ gm cm}^{-2} \text{ for}$$

showers of 3 × 10^5 particles and

$$\Lambda_2 = 107^{+16}_{-19} \text{ gm cm}^{-2} \text{ for}$$

showers of 8.5 × 10^5 particles. These results are compared with those of other experiments.

537.59

11244 STUDY OF EXTENSIVE AIR SHOWERS OF SUPERHIGH ENERGY.

A.T.Abrosimov, G.A.Basilevskaya, V.I.Solovieva and G.B.Khristiansen.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 89-95.

Extensive air showers having from 5 × 10^6 to 10^8 particles were studied. Data are given on the absolute shower intensity and the spectrum exponent with respect to the number of particles as well as on the spatial distribution of the electron—photon component and μ-mesons of these showers. The data on the electron—photon component show that in the lower atmosphere there is no equilibrium between the electron—photon component and the nuclear component in showers of superhigh energy and that the spatial distribution of electrons is determined not only by Coulomb scattering but also by the angular divergence of particles during nuclear cascade processes and spontaneous decays.

537.59 : 551.5

11245 ON THE PROBLEM OF THE NATURE OF SOFT RADIATION IN THE UPPER ATMOSPHERE.

L.I.Dorman.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 74-9.

Recent observations have yielded valuable information on bursts of soft radiation in the stratosphere. A series of studies was carried out in connection with five well-known big bursts. A summary is given of the available data on these phenomena together with an investigation of the question of their nature in relation to processes on the sun, in corpuscular streams and in the interplanetary medium, and also in relation to the properties of the earth's belts of radiation.

537.59

11246 ENERGY SPECTRUM OF COSMIC RADIATION PROTONS.

N.M.Kocharyan, G.S.Saakyan and Z.A.Kiracosvan.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 136.

Brief note, substantially as follows: In 4 independent experiments, the proton spectrum from 40 MeV to 66 BeV was measured at an altitude of 3200 m above sea level by means of the Alikhanov—Alikhanyan magnetic spectrometer. In the energy range E ≥ 3 BeV, the differential spectrum is approximated by the following power function:

$$N\,(E)\,dE = 3.2 \times 10^{-3}(2+E)^{-2.8}\,dE,$$

where E is the proton kinetic energy expressed in BeV. The obtained spectrum is compared with primary radiation spectra. For full text see Abstr. 12418 of 1959.

537.59

11247 STUDIES OF INTENSITY VARIATIONS OF COSMIC RADIATION IN THE STRATOSPHERE.

S.N.Vernov, B.E.Samosudov, V.F.Tulinov, A.N.Charakhchyan and T.N Charakhchyan.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 53-64.

Measurements in the stratosphere have yielded data on secular, 27-day intensity-variations of cosmic radiation, and also data on cosmic-ray variations that occur during very large magnetic storms. The following usual effect at great altitudes was detected. During intensity increases of cosmic radiation in northern latitudes (64°), at lower latitudes (51°) the reverse is observed (intensity decline).

537.59

11248 BALLOON FLIGHT INVESTIGATIONS OF PRIMARY COSMIC RAYS DURING SOLAR DISTURBANCES.

M.A.Pomeranyz, S.P.Agarwal and V.R.Potnis.

Cosmic Ray Conference, Moscow, 1959, English Edition(see Abstr. 7427 of 1960) Vol. IV, p. 65-73.

An extensive series of balloon flights was conducted during the peak of the present solar maximum, utilizing instruments identical with those which had been flown previously during the declining portion of the preceding solar cycle (1949-1952). During the interval July, 1957-September, 1958, no sporadic increases in intensity were detected at Swarthmore, Pennsylvania, by quadruple coincidence counter trains containing 86 g cm^{-2} of absorber. In eight cases, solar flares of Importance 2 or greater occurred while the instruments were aloft, and on one occasion (22 Aug., 1958) a large increase in the flux of low energy cosmic rays was observed at balloon altitudes elsewhere. A recurrence tendence with a periodicity of 28 ± 1 days was followed for about 5 months. The fluctuations in the counting rates of the balloon-borne instruments were correlated with those observed by ground-based neutron monitors, and the mean factor relating the relative changes is 1.6 ± 0.3. However, it is unlikely that this ratio remains constant.

537.59 : 523.7

SMALL EFFECTS OF SOLAR FLARES AND THE ENERGY SPECTRUM OF PRIMARY VARIATION OF COSMIC RAYS. See Abstr. 10502

537.59 : 523.7

STRUCTURE OF SOLAR CORPUSCULAR STREAMS AND THEIR EFFECT ON PRIMARY COSMIC RAYS. See Abstr. 10507

537.5

11249 THE EFFECT OF DIMINISHING SOLAR ACTIVITY AN COSMIC-RAY INTENSITY FROM MEASUREMENTS IN THE STRATOSPHERE.

Yu.G.Shafer.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. IV, p. 74-9.

To investigate variations of primary cosmic radiation of low energy in Yakutsk ($\Phi = 51^0$, $\Lambda = 193.8^0$) during the Third International Geophysical Year, regular measurements were conducted of the total intensity in the stratosphere by means of counter telescopes sent aloft in sounding balloons. In the present study an investigation is made of the intensity variations of cosmic radiation in the stratosphere as a function of the cycle of solar activity. The study also takes advantage of the entire assemblage of cosmic-ray studi in Yakutsk (the neutron component, the hard component at sea leve and underground to various depths.

537.

11250 BALLOON MEASUREMENTS ON TIME VARIATIONS OF PRIMARY COSMIC RADIATION.

A.Ehmert and H.Erbe.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. IV, 80-4.

Balloon borne coincidence telescopes were flown at different intensities of the ground components. The primary particle number can be evaluated, if a pressure of 20 mm Hg is reached. There is a strong correlation: 1% change of the number of the primaries at 49° geomagnetic latitude induces a change of 0.46% in the neutron number and of 0.22% in the meson number at the ground station. Comparing the latitude factors of the components the (first order) relation $(P-P_n)/P_n^2 = F(t)$ with P_n as "normal" value for any station is found. This confirms the electric field deceleration hypothesis.

537.59 : 523.75

11251 ON THE COSMIC RAY STORMS DUE TO THE SOLAR CORPUSCULAR STREAMS. M.Kitamura.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, 128-33.

The diffusion mechanism of the primary cosmic-ray particles into the magnetic clouds emitted from the sun, in which the disordered magnetic field is frozen, is discussed. The propagation process of cosmic-ray particles into the magnetic cloud has been treated by a diffusion equation. It is shown that the result of calculation of the cosmic-ray decrease on the earth as a function of geomagnetic latitude is in fairly good agreement with observed latitude effect of Forbush type decrease when the scattering length of the cosmic-ray particles in the magnetic clouds is proportional to $E^{0.2}$, where E denotes the energy of the particle.

537.59

11252 ON THE MODULATION OF THE PRIMARY COSMIC RAY SPECTRUM BY SOLAR ACTIVITY. A.Ehmert.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 142-8.

An experimentally found formula on the distribution of the amplitudes of world-wide variations is shown to agree with the electric field modulation hypothesis. By extrapolating the high energy distribution of primaries and calculating its deformation by electric field deceleration, full agreement with the experimental distribution is obtained. A deceleration potential of ~ 1 GV in sunspot minimum is increased by 0.8 GV from 1954 to the end of 1957 and the most severe Forbush decreases during magnetic storms need an augmentation of the deceleration field by ~ 1 GV within a few hours. A diminuation of the ionization at Huancayo by 0.62% corresponds to an increase of the earth's electric potential by 10^8 V. The possibility of a circumsolar electric field is discussed.

537.59

11253 STUDY OF THE COSMIC-RAY STORM BY JAPANESE GROUP. Y.Sekido.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 197-8.

Survey paper and introduction to a series of papers by the group.

537.59 : 523.16

11254 COSMIC-RAY STORMS AND SOLAR RADIO EMISSIONS. Y.Kamiya.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 199-201.

The study was restricted to data obtained during the I.G.Y. period from July, 1957 to December, 1958 and the following results obtained. (1) Every cosmic-ray storm occurs after a solar flare accompanied by a radio outburst of type IV. (2) The cosmic-ray decrease is nearly independent of the meridian distance where the respective outburst occurs. (3) Solar corpuscular clouds which contribute to the cosmic-ray storms may be emitted just on the occasion of type IV outbursts.

537.59

11255 TIME VARIATION OF THE ENERGY SPECTRUM OF COSMIC RAY PARTICLES DURING THE FORBUSH-TYPE DECREASE. M.Kitamura and M.Kodama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 202-7.

The latitude effect of the Forbush decreases of the cosmic-ray intensity has been analysed by using the world wide I.G.Y. data in order to study the time variation of the energy spectra during the cosmic-ray storms. It is found from this analysis that the energy E^X, above which higher energy particles of the primary cosmic-rays do not display the intensity decrease during the cosmic-ray storms shifts towards the high energy side with the development of the cosmic-ray storms and then towards the lower energy side with the recovery of the intensity decreases. Beside, it is suggested that the energy spectrum in the lower energy part changes to become flatter in the mature stage than that in other stage. These features may be explained by the model that the Forbush-type decreases take place due to the diffusion of the cosmic-ray particles into the magnetic clouds emitted from the sun, containing the disordered magnetic field. Furthermore, it is shown that decreases of cosmic-ray particles of low energy side recover more slowly than that of high energy side. This fact is favourable to the diffusion model on the cosmic-ray storm.

537.59

11256 ON WORLDWIDE COSMIC-RAY INTENSITY INCREASES ASSOCIATED WITH COSMIC-RAY STORMS. I.Kondo, K Nagashima, S.Yoshida, M.Wada.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 208-15.

An analysis of two cases has been previously reported (Abstr. 8273 of 1959). It was also found that the intensity increases are not caused by the so-called unusual increase associated with the solar flare Further, the worldwide character of the phenomena excluded the possibility that the increases are observed as the result of the anomalous diurnal variation associated with cosmic-ray storms. In order to study the cause of this intensity increase, one must know the dependence of the increments on latitude, longitude, altitude and components of cosmic-rays. As these increases were observed during the course of the 3rd International Geophysical Year, the cosmic-ray intensity variation were observed by many observatories over the globe. The data thus available was used in a detailed analysis. The results as shown in a series of diagrams.

537.59

11257 SOLAR DIURNAL VARIATION OF COSMIC RAYS. K.Nagashima.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 240-1.

In a previous paper (Abstr. 381 of 1959), it was suggested that the anomalous diurnal variation of cosmic rays during a cosmic ray storm is due to the presence of a uniform magnetic field frozen in a solar stream. But, it is more reasonable to suppose that, in an actual solar stream, a randomly distributed magnetic field also coexists with the uniform field. The influence of the random magnetic field upon the anomalous diurnal variation is examined.

537.59

11258 SIDEREAL ANISOTROPY OF HIGH ENERGY COSMIC RAYS. I.Escobar,V., N.Nerurkar and R.Weil.
Cosmic Ray Conference, Moscow, 1959, English Edition, (see Abstr. 7427 of 1960), Vol. IV, p. 273-80.

A report is made of the results obtainable from a second period of operation of an extensive shower monitor located at Chacaltaya, Bolivia. The results are consistent with those obtained during the first period of operation, namely, an anisotropy of the order of 1% at 19.0 Local Sidereal Time for the high energy showers, and isotropy for the lower energy showers recorded. It is shown that the pressure correction applied does not affect these results.

537.59

11259 THE 27-DAY RECURRENCE OF COSMIC-RAY INTENSITY AT THE MINIMUM SOLAR ACTIVITY. M.Kodama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 287-92.

There exists, in general, a close negative correlation between the 27 day recurrence tendency of cosmic rays and that of solar activity, Both recurrences have, however, a positive correlation during several months at the minimum solar activity. This phenomenon suggests that there may be at all times some solar emission of cosmic-ray particles, which is not observable except during the short period of minimum solar activity.

537.59

11260 SOLAR DISTURBANCES AND THE COSMIC RAYS EQUATOR. M.A.Pomerantz, A.E.Sandström, V.R.Potnis, D.C.Rose.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 337-43.

The location of the cosmic ray equator off the west coast of Africa has been established from measurements obtained with a shipboard neutron monitor which made ten crossings between November, 1956, and October, 1958. From the individual determinations of the point of minimum cosmic ray intensity, the mean geographical position was 6.7 ± 0.8°N at 14°W. Direct measurements of zero magnetic inclination were made at the same time in the immediate vicinity of this point. Although solar and geophysical activity varied considerably during this period, the location of the cosmic ray equator appears to have remained fixed within approximately 1°. However, the possibility of a small progressive change of about the magnitude of the uncertainty cannot be precluded. Comparison of the results with plots of measurements of the magnetic elements along the ship's route reveals a significant difference between the location of the points of maximum horizontal intensity and minimum cosmic ray intensity.

537.59

11261 COSMIC RAY INVESTIGATION WITH AN AIRBORNE NEUTRON MONITOR.

M.A.Pomerantz, V.R.Potnis and S.P.Agarwal.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 344-8.

A neutron monitor has been in operation aboard a magnetic survey aircraft. During a cruise in November, 1958, the latitude effect of the nucleonic component was measured over the same route between Tokyo and the Aleutian Islands as that covered by Sandström in February, 1957. Although the two sets of data normalized at Tokyo are in agreement up to approximately 43°N (modified geomagnetic latitude), a change in the shape of the curve had occurred at higher latitudes. The intensity at 55°N had decreased by 13%, and the "knee" had shifted from 47°N to 43°N. The latitude variation of the absorption mean free path was determined for intensity versus altitude curves at geomagnetic latitudes 50°N, 37°N, 25°N, and 13°N. A change of roughly 10% over a range of primary cutoff rigidity from 2 GV was indicated. Comparison with earlier results of others revealed no appreciable variation of the mean free path during the solar cycle.

537.59

11262 THE WORLD-WIDE DISTRIBUTION OF COSMIC-RAY NEUTRON INTENSITY AT SEA LEVEL.

M.Kodama.

Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 349-61.

The world-wide distribution of cosmic ray neutron intensity at sea level was decided from the several latitude curves so far measured by many researchers. The contour map thus obtained was compared with the various models for the earth's geomagnetic field.

537.59

11263 A COINCIDENCE TELESCOPE FOR THE TEACHING OF COSMIC RAY PHYSICS.

V.Hovi and A.Aurela.

Ann. Univ. Turku AI, No. 33, 7 pp.(1959).

537.59

11264 COSMIC-RAY HEAVY NUCLEI AT THE GEOMAGNETIC EQUATOR.

D.D.Kerlee, O.K.Krienke,Jr, J.J.Lord and M.E.Nelson.

Phys. Rev., Vol. 118, No. 3, 828-30 (May 1, 1960).

The flux of primary cosmic-ray heavy nuclei was measured with a sandwich of C-2 and G-5 emulsions near the island of Guam, magnetic latitude 4°N. The emulsions were exposed at about 101 000 ft for 7.3 hr and the calculated fluxes at the top of the atmosphere in particles/m^2 sec sr were found to be:

Li, Be, B	(L nuclei)	0.26 ± 0.05
C,N,O,F	(M nuclei)	0.66 ± 0.10
$Z \geq 10$	(H nuclei)	0.37 ± 0.09.

This flight took place on Feb. 12, 1957, about a year prior to the sun spot maximum; however, there is no evidence within statistical error for any changes in the composition of the primary heavy nuclei.

537.59

11265 ON THE STRUCTURE OF EXTENSIVE AIR SHOWERS.

A.Ueda and N.Ogita.

Progr. theor. Phys., Vol. 18, No. 3, 269-86 (Sept., 1957).

Assuming a simple model of extremely high energy collisions, the relation is studied between the one-dimensional development of extensive air showers and the mechanism of multiple meson production. The gross structure of extensive air showers based on the model is given graphically or numerically, in a form useful, as a first step, for further investigations. In particular, the effect of varying the value of the inelasticity of high-energy collisions is discussed. As a preliminary conclusion it is shown that it seems difficult to explain the experimental result of the constancy of the attenuation length of the electron component over a wide range of primary energies, 10^{14}—10^{17} eV, without introducing any energy dependence of the inelasticity or a stronger energy dependence of multiplicity with increasing energy, though more abundant and reliable data seems desirable. Attention is also paid to the problem of what quantities must be measured to determine more directly and less ambiguously the angular and energy distributions of secondary particles produced by high-energy collisions.

537.59

11266 THE DEPENDENCE OF THE ANGLE BETWEEN THE DIRECTION OF MOTION OF SHOWER PARTICLES AND THE AXIS OF THE SHOWER ON THE DISTANCE FROM THE AXIS.

V.V.Guzhavin and I.P.Ivanenko.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1509-12 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1070-2 (Nov., 1959).

The dependence of the mean angle between the motion of particles and the axis of a shower on the distance from the axis is calculated. The case considered is that of an electron—photon shower averaged over the depth, with no account taken of ionization losses. The results of the calculation are compared with experimental data.

537.59

11267 NUMERICAL CALCULATIONS ON THE NEW APPROAC TO THE CASCADE THEORY. II.

S.K.Srinivasan and N.R.Ranganathan.

Proc. Indian Acad. Sci. A, Vol. 45, No. 4, 268-72 (April, 1957).

For Pt I,see Abstr. 6317 of 1957. Numerical results on the mean numbers of electrons produced in small thicknesses in a shower initiated by a single electron are presented on the basis of the new approach to the cascade theory.

537.59

11268 A THEORY OF PASSAGE OF NUCLEAR CASCADES THROUGH THE ATMOSPHERE.

I.P.Ivanenko.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1046-9 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 744-6 (April, 1960).

A method for solution of the equations describing the passage o nuclear cascades through the atmosphere is proposed. The boundar conditions can be prescribed at an arbitrary depth. The proposed method makes if possible to obtain the solution in a form similar to that obtained by the usual method of successive generations with boundary conditions prescribed at the top of the atmosphere. The form of the solutions is discussed for various types of boundary conditions.

537.5

11269 MONTE CARLO CALCULATIONS OF ELECTROMAGNETIC CASCADES TAKING INTO ACCOUNT THE INFLUENCE OF THE MEDIUM ON BREMSSTRAHLUNG.

A.A.Varfolomeev and I.A.Svetlolobov.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1771-81 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New Yor Vol. 36 (9), No. 6, 1263-70 (Dec., 1959).

Calculations of electromagnetic cascades, initiated by primary electrons with energies of 10^9, 10^{10}, 10^{11}, 5×10^{11}, 10^{12} and 3×10^{12} have been performed for depths up to 2.8 radiation units. The Monet Carlo method was used. Actual cross-sections (not asympto for the elementary electromagnetic processes in the nuclear emulsions were employed. Two types of calculation were carried out: those using the Bethe-Heitler formula and those based on formulae that take into account the influence of multiple scattering and polarization on the medium on bremsstrahlung.

537.5

11270 INVESTIGATION OF HIGH-ENERGY NUCLEAR-ACTIV PARTICLES AT SEA LEVEL.

V.A.Dmitriev, G.V.Kulikov and G.B.Khristiansen.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 893-905 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New Yor Vol. 37(10), No. 4, 637-47 (April, 1960).

Large bursts in an ionization chamber located under a filter w is highly efficient with respect to nuclear interactions were studie It is shown that at sea level the majority of the big bursts (≥ 1000 relativistic particles) are due to interactions, in the filter, of nucl active particles with energies $E \geq 10^{12}$ eV. The spectrum of the nuclear-active particles and their air "accompaniment" is present

The accompanying particles can be explained by fluctuations in the development of nuclear cascades in the atmosphere. The cross-section for interaction of $\sim 10^{13}$ eV particles with nuclei of atmospheric atoms is estimated. Cases of high-energy nuclear-active particle beams are reported.

537.59

11271 MOMENTUM SPECTRUM OF PARTICLES OF THE HARD COMPONENT OF COSMIC RAYS AT AN ALTITUDE OF 9 kM.

L.T.Baradzei, M.V.Solov'ev, Z.I.Tulinova and L.I.Filatova.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1617-20 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1151-4 (Dec., 1959).

Measured, with the aid of a cloud chamber placed in a magnetic field, in the range $0.3 \times 10^9 - 6 \times 10^9$ eV/c. The particles were also grouped according to the charge. It was found that the $(1-5) \times 10^9$ eV/c protons comprise (50 ± 10)% of the total number of particles.

537.59

11272 DECREASE OF COSMIC-RAY INTENSITY ON FEBRUARY 11, 1958. J.A.Lockwood.

J. geophys. Res., Vol. 65, No. 1, 27-38 (Jan., 1960).

An analysis has been made of the cosmic-ray data recorded by the I.G.Y. network of stations during the sudden decrease of intensity on February 11, 1958. The unusual rapidity of the decrease, which was followed by a temporary recovery, provides a critical test for existing solar-controlled modulating mechanisms. The main decrease, occurring practically simultaneously over the earth, was relatively energy-insensitive. The subsequent temporary recovery appeared to be associated with a spatial anisotropy. It is suggested that these variations can be interpreted as the result of disordering the outer geomagnetic field by the solar wind, as first pointed out by Parker (see Abstr. 4642 of 1958).

537.59

11273 DAY TO DAY ANALYSIS OF THE COSMIC RAY DIURNAL WAVE IN 1958. J.F.Steljes.

Nuovo Cimento, Vol. 13, No. 4, 857-63 (Aug. 16, 1959).

The cosmic ray neutron intensity was studied at Deep River, Ontario, using a recorder sufficiently large to allow a day-to-day analysis of the diurnal effect. Data obtained in March, June and August 1958 are presented. These have been analysed by fitting a harmonic wave of 24 hr period but variable amplitude and phase to each day. Fluctuations in amplitude and phase were found to follow a Forbush decrease, but also occurred without large changes in mean intensity. Values of the amplitude of the diurnal wave and of the time of its maximum were compared with similar data from other observatories. An explanation for the different appearance of a Forbush decrease at widely separated stations is suggested.

E.G.Michaelis

537.59

11274 THE UNUSUAL COSMIC RAY EVENTS OF JULY 17-18, 1959. B.G.Wilson, D.C.Rose and M.A.Pomerantz.

Canad. J. Phys., Vol. 38, No. 2, 328-31 (Feb., 1960).

Intensity changes on 17-18 July 1959 were recorded at five Canadian stations and at Thule. It is found that rapid increases in intensity, which show decided differences at different localities, have occured after Forbush events. All intensity changes are discussed and the possibility is mentioned that one or more of the intensity changes may later be shown to be due to a flow of particles of solar origin.

E.W.Kellermann

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11275 THE COSMIC RAY INCREASE OF 17 JULY 1959.

D.K.Bailey and M.A.Pomerantz.
Canad. J. Phys., Vol. 38, No. 2, 332-3 (Feb., 1960).

Evidence is presented, from ionospheric scatter signal intensity observations at about 38 Mc/s, that the sun emitted particles of cosmic-ray energy on 17 July 1959, the date on which Wilson at al. (see preceding Abstract) observed unusual cosmic-ray intensity changes. It is suggested that available evidence is compatible with the presence on 17 July of flare-associated cosmic-rays having rigidities above the geomagnetic cut-off.

E.W.Kellermann

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11276 EFFECTS OF PI MESON DECAY-ABSORPTION PHENOMENA ON THE HIGH-ENERGY MU MESON ZENITHAL VARIATION NEAR SEA LEVEL.

J.A.Smith and N.M.Duller.
J. geophys. Res., Vol. 64, No. 12, 2297-306 (Dec., 1959).

An approximate calculation of the ground-level high-energy μ-meson intensities is presented, with curves showing peculiar maxima in the angular vicinity from about 55° to 75° with respect to the vertical at ground-level energies from about 60 GeV to 160 GeV. The effects are explained in terms of well-known π-meson decay—absorption phenomena high in the earth's atmosphere.

537.59

11277 ON THE LONG-TERM VARIATION IN THE COSMIC RADIATION. J.A.Lockwood.

J. geophys. Res., Vol. 65, No. 1, 19-26 (Jan., 1960).

From an analysis of the cosmic-ray intensities recorded at Mt. Washington, Mt. Norikura and Huancayo from 1954 to 1958, the long-term variation of intensity is interpreted as occurring in several sudden decreases rather than gradually. The largest changes of cosmic-ray intensity and in the ratios of intensities recorded by the three detectors followed the occurrence of large Forbush-type decreases. The depressed intensity following the rapid decrease of July 11, 1959, further supports this interpretation. Frequency distributions of the changes in nucleonic intensity from day to day show the importance of the Forbush decreases to the long-term variation. These results are discussed in terms of possible solar modulating mechanisms.

537.59

11278 GEOMAGNETIC EFFECTS ON COSMIC RADIATION FOR OBSERVATION POINTS ABOVE THE EARTH.

J.E.Kasper.
J. geophys. Res., Vol. 65, No. 1, 39-54 (Jan., 1960).

The theory of geomagnetic effects on cosmic radiation is discusse for the case in which the point of observation is above the surface of the earth. Parts of the older geomagnetic theory are readily modifiable for application under the new conditions; the manner in which ordinary Störmer theory and the Lemaitre—Vallarta theory of the main cone can be adapted is discussed. However, the simple shadow cones of Schremp appear now in a new light; as the point of observation rises from the earth, the simple shadow effect which exists at the earth makes a smooth transition to a new kind of earth's shadow effect. Associated with this effect are principal shadow cones which are defined by reference to the properties of certain families of trajectories. For observation points above the earth, a modification in the accepted view of the penumbral region is required; this is discussed very briefly. Extensive computations of principal shadow cones have been carried out by machine integration of the equations of motion and subsequent abstraction of data from these trajectories. Sample computed cones are given for representative particle rigidities geomagnetic latitudes, and altitudes of observation. The centred dipole approximation for the magnetic field of the earth is used throughout.

537.59

11279 A CASE OF A SHARP INCREASE IN COSMIC-RAY INTENSITY IN THE STRATOSPHERE.

N.P.Rȳmko, V.F.Tulinov and A.N.Charakhch'yan.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1687-9 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1202-3 (Dec., 1959).

An increase in the intensity of cosmic radiation was observed in the stratosphere on 8 July, 1958 at a latitude of 64°N. At an altitude of 30 km, the intensity was more than twice the normal value. No increase was observed at latitudes of 51° and 41°.

537.59

11280 A REMARK ON HIGH ENERGY PHENOMENA.

S.Amai, T.Murota and M.Nishida.
Progr. theor. Phys., Vol. 17, No.6, 807-12 (June, 1957).

A possible model which discriminates π—N, K—N and N—N collisions in the cosmic-ray energy region is proposed. The difference in dependence of the multiplicities on the energy of incident particles in π—N, K—N and N—N collisions is discussed, which is due to the difference of the kinds of the incident particles. Experimental data obtained with nuclear emulsions are analysed using this model. If the model is justified, the mean energy of the secondary particles of the π-primary jets must be greater (about twice) than that of the N-primary one, both in nucleon and nuclear targets.

537.59

11281 PRODUCTION OF PIONS BY HIGH-ENERGY COSMIC-RAY ALPHA PARTICLES.

A.A.Loktionov and Zh.S. Takibaev.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1697-702 (June, 1959). In

Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1209-12 (Dec., 1959).

Experimental results are compared with the hydrodynamical theory of multiple meson production. It is shown that, for showers with energy >~ 10 GeV per nucleon, the results of an analysis of the parameters of observed stars do not contradict the concept of an interaction between the incident α-particle and nucleons filling a tunnel in the target nucleus.

537.59

11282 COSMIC-RAY PRODUCTION RATES OF Be^7 IN OXYGEN, AND P^{32}, P^{33}, S^{35} IN ARGON AT MOUNTAIN ALTITUDES.

D.Lal, J.R.Arnold and M.Honda.

Phys. Rev., Vol. 118, No. 6, 1626-32 (June 15, 1960).

The production rates of radioisotopes P^{32}, P^{33}, and S^{35} in argon, and of Be^7 in oxygen have been measured by exposing argon and water to cosmic rays at mountain altitudes for periods of 2-4 months during 1959. The measured values at $\lambda = 51^\circ$N, atmospheric depth 685 g cm^{-2}, are 7.6×10^{-6}, 6.2×10^{-6}, 1.4×10^{-5} atoms (g argon)$^{-1}$ sec^{-1} of P^{32}, P^{33}, and S^{35}, respectively, and 9.0×10^{-6} Be^7 atoms (g oxygen)$^{-1}$ sec^{-1}. Isotope production rates for all regions in the atmosphere have recently been calculated by Lal et al. (Abstr. 2041 of 1960). The measured production rates are higher than the calculated rates by factors of 1.1, 1.8, 1.4 and 1.8 in the case of radioisotopes Be^7, P^{32}, P^{33}, and S^{35}, respectively. In this comparison, account has been taken of the fact that cosmic-ray intensity has decreased by about 15% since 1948, the time period to which the calculations apply. The measured production rates in oxygen are assumed to apply to air since cross-sections for Be^7 formation have been found to be the same in nitrogen and oxygen over most of the energy region of interest. The procedure used by Lal et al. yields a fairly accurate picture of the variation in production rates with altitude and latitude in the atmosphere. Isotope production rates in all regions of the atmosphere can, therefore, be obtained by normalizing their calculations at the points where these measurements have been made. The calculated production rates of these isotopes in the troposphere, and in the stratosphere corresponding to observed cosmic-ray intensity during 1948-49, are given. The available data on the concentration of the isotopes in rain-water and their averaged yearly deposition rates are compared with their revised production rates. From such a comparison, more definite conclusions can be drawn than hitherto possible in view of the more accurate knowledge of isotope production rates. See also Abstr. 11407 of 1960.

NUCLEUS

539.14 : 536.48

A DEVICE FOR ORIENTING NUCLEI. See Abstr. 10857

539.14

11283 METHOD FOR SEPARATING THE RELATIVE MOTION OF TWO NUCLEONS IN OSCILLATOR POTENTIAL WELL.

V.V.Balashov and V.A.Eltekov.

Nuclear Phys., Vol. 39, No. 3, 423-31 (May (2), 1960).

Invariant coefficients independent of magnetic quantum numbers are introduced for separating the relative motion of two nucleons in an oscillator potential well ("generalized Talmi coefficients"). Tables of these coefficients are given for the first oscillator states including 3p and 3f shells.

539.14

11284 THE NUCLEON—NUCLEON SPIN—ORBIT POTENTIAL.

G.Briet.

Proc. Nat. Acad. Sci. U.S.A., Vol. 46, No. 5, 746-53 (May, 1960).

The possiblity of regarding the nucleon—nucleon spin—orbit interaction and repulsive core as orginating in a coupling of the nucleon to a heavy vector meson is discussed. The mass required for this meson to give the required spin—orbit potential in about eleven pion masses. It is further shown that this meson introduces no obvious contradictions with experiment, and may by of use in explaining the neutron form factor. E.J.Squires

539.14

11285 PAIRING ENERGY OF NUCLEAR PARTICLES.

M.Nomoto.

Progr. theor. Phys., Vol. 18, No. 5, 483-92 (Nov., 1957).

From the nuclear binding energies given by Wapstra, the pairing energies of identical nucleons have been computed and found to be expressible in the form $(22.3 \pm 5.5)\,(2j + 1)/A$ MeV for even—eve nuclei with mass number A, and pairs in a definite j-shell. By using the computed values of the pairing energy for the even—even and odd A nuclei and assuming the zero range force, it is found that the inter-nucleon potential is

$$V_{ij} = -570 r_0^3 [1 + (0.16 \pm 0.15)\sigma_i . \sigma_j] \delta(r_i - r_j) \text{ MeV},$$

where r_0 is the nucleon radius.

539.14

11286 MODIFICATION OF THE FORM OF POTENTIAL IN AN EXCITED NUCLEUS AND ITS EFFECT ON THE BARRIE TRANSMISSION COEFFICIENT.

J.Németh.

Nuclear Phys., Vol. 16, No. 2, 331-8 (May (1), 1960).

The transmission coefficient of the nuclear potential barrier is calculated by taking into account the fact that the density distribution of an excited nucleus differs from that of one in the ground state. As an example the potential barrier of an excited nucleus of mass number 40 is determined on the basis of the statistical model and it is found that for 15 MeV excitation energy, the transmission coefficient for protons emitted with 2 MeV energy is twice as large as that for a nucleus in the ground state.

539.14

11287 ON THE COUPLING OF A $j = \frac{3}{2}$ PARTICLE TO NUCLEAR QUADRUPOLE SURFACE OSCILLATIONS.

B.F.Bayman and L.Silverberg.

Nuclear Phys., Vol. 16, No. 4, 625-44 (June (1), 1960).

An intermediate-coupling calculation is performed for a nucleon confined to move in a $j = \frac{3}{2}$ orbit and coupled to a nuclear surface capable of performing quadrupole oscillations. It is shown that each term in the Hamiltonian commutes with a symplectic group of transformations. This feature is used to define a representation in which the Hamiltonian matrix takes an especially simple form. It is possible to follow the transition from weak to strong coupling, at which there appear sets of rotational bands built on equidistant vibrational excitations. These rotational bands have some special features due to the γ-instability of the problem.

539.14 : 539.17

11288 THE OPTICAL MODEL AND INELASTIC SCATTERING.

L.S.Rodberg.

Ann. Phys. (New York), Vol. 9, No. 3, 373-90 (March, 1960).

Calculations of Levinson and Banerjee (Abstr. 1945-6, 3365 of 1958) using the direct-interaction model for the inelastic scattering of protons, indicated that the optical potential seen by the scattered particle is weaker than for the corresponding elastic scattering process. In this paper, the scattering amplitude is derived and the "1/A-corrections" to it are examined. It is shown that these represent corrections to the optical potential and arise from the requirement that the contribution of a given target nucleon to the optical potential be removed when that nucleon is interacting directly with the incident particle. It is shown that the short range, symmetry-dependence and spin-dependence of nuclear forces can make this an important correction and can explain the Levinson—Banerjee reduction. It is also shown that the strength of the effective two-body interaction, or t-matrix, is in good agreement with the strengt found by Levinson and Banerjee. The distorted-wave direct-interaction model is therefore capable of predicting the absolute magnitude of the inelastic cross-section.

539.1

11289 ON THE AXIAL SYMMETRY OF THE NILSSON MODEL NUCLEUS.

T.D.Newton.

Canad. J. Phys., Vol. 38, No. 5, 700-8 (May, 1960).

The validity of the assumption of axial symmetry in the Nilsso model of the nucleus is tested by investigating what shape of potential gives minimum energy for a given number of particles. The energy of the ground state as a function of distortion parameters is shown for five model nuclei. The general features show that the energy minima become broader as the spin-orbit coupling is decreased from zero, and non-axially symmetric shapes giving a reduction in energy of 10-15% of ($\hbar\omega$) are found for some sets of particles. However, the shape giving minimum energy is not alway well defined. E.A.Sanders

539.14

11290 COMMENTS ON DAVYDOV AND FILIPPOV'S THEORY OF THE PROPERTIES OF EVEN NUCLEI.

.Tamura and T.Udagawa.
uclear Phys., Vol. 39, No. 3, 460-73 (May (2), 1960).

It is shown that all the experimental data on even nuclei, which he theory of Davydov and Filippov (Abstr. 1722 of 1959) explains, an as well be explained by more conventional theories. It is further hown that there exist several experimental results in which the heory of Davydov and Filippov may meet with difficulty, but which ould be explained by the conventional theory.

539.14

11291 NUCLEAR SHELL MODEL: HARTREE–FOCK APPROXIMATION WITH GAMMEL–THALER TWO-UCLEON POTENTIAL. G.E.Tauber and Ta-You Wu.

uclear Phys., Vol. 16, No. 4, 545-67 (June (1), 1960).

To investigate how good or bad the Hartree–Fock approximation s for the atomic nuclei, a calculation was carried out with the henomenological two-nucleon potential $V(\vec{r}_i - \vec{r}_j)$ of Gammel–Thaler Abstr. 2997, 7971 of 1957) containing a repulsive core, a central, a ensor and an $\vec{L} \cdot \vec{S}$ interaction. Harmonic oscillator wave-functions re used for the one-nucleon wave-functions. The parameters in the vave-functions and a multiplicative parameter in $V(\vec{r}_i - \vec{r}_j)$ are etermined from O^{16} by the variational principle and the empirical otal energy. These (now fixed) parameters are then used to calculate the energy of the configuration $(1s)_\nu{}^2\ (1p)_\nu{}^5\ (1s)_\pi{}^2\ (1p)_\pi{}^6$ of O^{15}. t is found that the $\vec{L} \cdot \vec{S}$ term in $V(\vec{r}_i - \vec{r}_j)$ gives rise to a doublet $(J = \frac{3}{2}) - E(J = \frac{1}{2}) = +31.6$ MeV. The total binding energy is $(J = \frac{1}{2}) = -114.8$ MeV compared with the empirical value −111.97 eV. The sign of this doublet corresponds, on the picture of the ndividual nucleon moving in an effective central field and possessing n $\vec{l}_i \cdot \vec{s}_i$ interaction, to a sign of $\vec{l}_i \cdot \vec{s}_i$ opposite to that of the electron, nd is in agreement with the fundamental hypothesis of the nuclear hell model of Mayer (Abstr. 1911, 6006-7 of 1950) and of Jensen t al. (Abstr. 7193 of 1949). The magnitude of the doublet, however, s too large, by a factor of about 5. These results are discussed.

539.14

11292 THE NUCLEON–CORE MODEL WITH A VIBRATIONAL EXCITATION SPECTRUM OF THE CORE.

.P.Grechukhin.
h. eksper. teor. Fiz., Vol. 37, No. 4(10), 1026-33 (Oct., 1959). In ussian. English translation in: Soviet Physics – JETP (New ork), Vol. 37(10), No. 4, 730-5 (April, 1960).

The nucleon + core model with intermediate coupling between he nucleon and phonon excitations of the core has been considered s a possible way of describing the spectra of odd nuclei in the tomic weight region in which even-even nuclei possess level pacings similar to the vibrational quadrupole excitations of the uclear surface (phonons). The state of the nucleon + core system s a superposition of nucleon states and core states with various umbers of phonons. The energy levels and wave-functions of the ystem have been approximately determined by diagonalizing the nergy matrix which is cut off at a certain number of phonons N. onvergence of the approximation when the cut-off is carried out t various values of N is investigated in the present work for the imple model of spinless phonons whose energy matrix retains the ain features of the matrix for phonons with spin.

539.14

11293 AN INVESTIGATION OF THE SUPERFLUID STATE OF AN ATOMIC NUCLEUS. V.G.Solov'ev.

h. eksper. teor. Fiz., Vol. 36, No. 6, 1869-74 (June, 1959). In ussian. English translation in: Soviet Physics–JETP (New York), ol. 36(9), No. 6, 1331-4 (Dec., 1959).

The variational principle proposed by Bogolyubov and the physic- l ideas and mathematical methods developed in the theory of superonductivity are applied to a study of the properties of a heavy ucleus. Using the nuclear shell model, the residual interactions f nucleons in an outer shell are considered; this leads to the appearnce of a superfluid state of the nucleus. An evaluation is made of e energy of the superfluid ground state and of the energies of a umber of excited states, both in the case of an even and in the case an odd number of nucleons in the shell. Some regularities were und in the level spectrum of even–even nuclei and of odd A nuclei. hanges in the nuclear ground state energy were evaluated for the ase where the number of outer shell nucleons was changed by one; is made it possible to conclude that even–even nuclei are more table than odd–odd nuclei as regards β-decay, which agrees numerically with von Weizsäcker's semi-empirical formula. The results obtained depend little on the nuclear model chosen, and they are also valid for highly deformed nuclei.

539.14 : 539.12

11294 QUESTION OF NUCLEON CLUSTERS IN THE NUCLEAR SURFACE. I.E.McCarthy and D.J.Prowse.

Phys. Rev. Letters, Vol. 4, No. 7, 367-9 (April 1, 1960).

A mechanism is given that explains the absorption of K^- mesons by nuclei in photographic emulsions. This interpretation, unlike that of Wilkinson, does not require nucleon clusters in the nuclear surface. A.M.Green

539.14

11295 NEUTRON–PROTON PAIRING INTERACTION IN TRANSURANIC ELEMENTS. N.C.Ghosh and D.Sen.

Proc. Phys. Soc., Vol. 75, Pt 5, 689-96 (May, 1960).

An attempt was made to analyse the data on the last-nucleon binding energies of transuranic elements. Some interesting results are obtained regarding the behaviour of the λ-term introduced by Ghoshal and Saxena (see Abstr. 5315 of 1956). Some confirmatory evidence is also obtained regarding the subshell at N = 152.

539.14 : 539.17

11296 SYSTEMATICS OF NEUTRON SEPARATION ENERGIES.

K.N.Geller, J.Halpern and E.G.Muirhead.
Phys. Rev., Vol. 118, No. 5, 1302-12 (June 1, 1960).

Photoneutron thresholds for 73 nuclides were measured by radioactivity and neutron-detection methods using a 25 MeV betatron. The neutron separation energies inferred from the observed thresholds are in general agreement with the values predicted from mass data and reaction energies. Several discrepancies are observed between threshold and neutron binding energies where ground state transitions require a spin change ≥ 7/2. For these nuclei, the threshold energies are consistent with neutron emission leaving the residual nucleus in an excited state.

539.14

11297 A REMARK ON THE MOMENTS OF INERTIA OF ROTATING NUCLEI. S.Hayakawa and T.Marumori.

Progr. theor. Phys., Vol. 18, No. 4, 396-404 (Oct., 1957).

The quantum mechanical description of a two-dimensional rotating system of particles is studied for the purpose to elucidate the meaning of the effective moments of inertia of nuclei. The method of canonical transformations is employed and the rotational kinetic energy of a "canonical form" is obtained by introducing an internal angular momentum L_{in}. The Coriolis force arising from the coupling of L_{in} with the rotational angular velocity is found to be responsible for the deviation of the moment of inertia from its hydrodynamical value. The explicit form of L_{in} is given as a function of the positions and momenta of individual particles. This form of L_{in} should be used for deriving the effective moment of inertia. Comparison with the cranking model of Inglis (Abstr. 623 of 1957) is discussed.

539.14

11298 ON THE GROUND STATE SPIN OF Ti^{47} AND Mn^{55}.

S.Yanagawa.
Progr. theor. Phys., Vol. 18, No. 6, 661-2 (Dec., 1957).

The energy splittings in the $f_{7/2}^{\pm 3}(J)$ states with J = 3/2, 5/2 and 7/2 are calculated in terms of the experimental energy differences of the $f_{7/2}^{\pm 2}(J)$, J = 0, 2, 4 and 6 states. Configuration mixing is ignored. In this way the spins of the ground states of certain nuclei can be predicted. E.J.Squires

539.14

11299 SUPERCONDUCTOR MAGNETS FOR ORIENTATION OF NUCLEI.

A.V.Kogan, V.D.Kul'kov, L.P.Nitkin and N.M.Reinov.
Zh. tekh. Fiz., Vol. 29, No. 11, 1419-20 (Nov., 1959). In Russian. English translation in: Soviet Physics–Technical Physics (New York), Vol. 4, No. 11, 1308-9 (May, 1960).

The magnetic field, trapped inside a cylinder of niobium foil which has become superconducting during the adiabatic demagnetization process, can be used for nuclear orientation experiments; a method of so doing is described and some results of experiments with Co^{60} nuclei are given. The advantages and disadvantages of this method are briefly discussed. L.Mackinnon

539.14

11300 NUCLEAR MOMENTS AND CONFIGURATION MIXING.

H.Noya, A.Arima and H.Horie.

Suppl. Progr. theor. Phys., No. 8, 33-112 (1958).

The nuclear static moments are calculated from the standpoint of configuration mixing in the jj-coupling shell model. The residual interactions between particles in different orbits are taken as the cause of the configuration mixing. They are estimated from the observed data on the pairing energies assuming pure configurations. The calculations of nuclear moments are based on the first order perturbation theory. The single-particle energy differences in the energy denominators are estimated from a shell model Hamiltonian which gives fairly good agreement with observed single-particle levels, and the denominators contain the pairing effects in the zero-th order states. Both the harmonic oscillator and square-well wave-functions are adopted as the single-particle wave-functions. Various features of the deviations of magnetic dipole moments from the Schmidt lines are well interpreted by the configuration mixing for almost the whole region of nuclei. The quadrupole moment of odd-neutron nucleus can be accounted for from the mixing of excited states of the ground configuration and of higher configurations of even numbers of protons. For those of odd-proton nuclei, the corrections by the similar mixing are almost as large as the single-proton values so that the quadrupole moments of the medium-weight nuclei which are two to three times as large as the single-proton values can be explained. However, the large quadrupole moments of the heavy nuclei cannot be interpreted by the perturbational treatment of the configuration mixing. The corrections to the magnetic dipole moments of odd-odd nuclei are calculated and good agreement with observed values is obtained. The magnetic octupole moments of odd-A nuclei are also considered on the same basis and general features of the observed values are well accounted for. However, the observed values are so few that a definite conclusion cannot be drawn. The numerical results are not sensitive to the choice of the single-particle wave functions, as far as the harmonic oscillator and the square well wave functions are employed. The second order effects are estimated by calculating the mixing probabilities of excited configurations into the ground state for a simple example of S^{33}, and the treatment by the first order perturbation theory appears justified at least for the medium-weight nuclei. The interactions with finite ranges are also considered and it is shown that, if a suitable exchange character is adopted for the interactions, the results are not much different from those by the delta-function interactions.

539.14

11301 ELECTRIC AND MAGNETIC MOMENTS OF ODD-NEUTRON NUCLEI ON THE SINGLE CONFIGURATION MODEL.

H.Narumi and H.Nagai.

Nuclear Phys., Vol. 16, No. 2, 193-205 (May (1), 1960).

Without taking account of the effect of configuration mixing, the authors attempt to derive electric as well as magnetic moments of odd-neutron nuclei on the basis of the single-configuration model. The quadrupole moments of odd-neutron nuclei may be obtained by the promotion of two protons from the zeroth-order proton state of seniority zero to the states of seniority two. The mixing coefficients of the ground state are determined by fitting the wave-function to the magnetic moment of the odd-neutron nucleus considered. Fairly good agreement is obtained between the calculated and observed values except for the nuclei with very large quadrupole moments and for the nuclei in the vicinity of each closed shell. The quadrupole and hexadecapole moments of the first excited state of Cd^{111} are evaluated.

539.14

11302 A CONTRIBUTION TO THE STUDY OF ELECTRIC DIPOLE TRANSITION IN THE REGION OF THE RARE EARTHS. (DISINTEGRATION OF Gd^{153}, Eu^{155}, Tb^{161}, W^{187}).

M.Vergnes.

Ann. Phys. (Paris), Ser. 13, Vol. 5, No. 1-2, 11-69 (Jan.-Feb., 1960). In French.

Weiskopf's predictions from the independent particle model fail to explain the small probability for low energy electric dipole transitions in deformed nuclei. Further examples of such transitions were found in the above heavily deformed nuclei and the measured transition probabilities of these and other previously observed transitions explained in terms of the predictions of the Nilsson model.

S.E.Hunt

539.

11303 QUADRUPOLE MOMENT OF Er^{168}.

É.E.Berlovich, V.G.Fleisher, V.I.Breslav and B.K.Preobrazhenskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1589 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York Vol. 36(9), No. 5, 1128-9 (Nov., 1959).

The half-life of the 80 keV level of Er^{168} was measured by a delayed coincidence method and from this result the quadrupole moment and deformation parameter calculated. The results are in agreement with values previously obtained from Coulomb excitatio

L.L.Gree

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11304 THE NUCLEAR QUADRUPOLE MOMENT OF K^{40}.

H.Bucka, H.Kopfermann and J.Ney.

Z. Phys.,Vol. 159, No. 1, 49-50 (1960). In German.

Investigates the hyperfine structure of the $5^2P_{3/2}$ term in the spectrum of K^{40} with the double resonance method.

S.J.St-Lora

539.14 : 539.

11305 EFFECTS OF A NUCLEAR OCTUPOLE MOMENT ON NEUTRON SCATTERING.

K.W.McVoy.

Phys. Rev., Vol. 118, No. 5, 1323-30 (June 1, 1960).

Recent applications of the nuclear optical model to the description of neutron scattering by spheroidal nuclei have shown that "shape effects" are very important for highly deformed nuclei. It has also been found that the "adiabatic approximation", which assumes the nucleus to be rigidly fixed in orientation throughout the scattering, is remarkably accurate for very low-energy (S-wav neutrons. A detailed investigation of this approximation is made, showing that the major factor determining its validity for the heav nuclei to which it has been applied is the large size of the "effective rotating mass" of the nucleus in comparison to the neutron mass. Thi analogous to the Born—Oppenheimer approximation in molecular physics, where the large ratio of nuclear to electronic mass enables o to calculate electronic wave-functions by considering the slower nucl motion to be "frozen" completely. Further, the effect is studied of a " shaped" deformation, or octupole moment, of the nuclear optical potential on the S-wave neutron strength function. (A square-edge potential well is used, which is somewhat similar in its effect to a rounded-edge well with a smaller imaginary potential). This is do for the very heavy nuclei, $225 < A < 240$, where the possibility of octupole deformations has been suggested by other data. The effe of a small octupole moment for these particular nuclei is found to largely masked by the nearly indistinguishable effect of their larg quadrupole moments, and, in view of the uncertainty in their quad pole moments, neutron scattering at this time cannot be said to provide any positive evidence of octupole moments. On the contra if the quadrupole moments reported from Coulomb excitation measurements are employed, the measured neutron strength func puts an upper limit on the octupole moments of about one-third th quadrupole moment. More accurate data, both on the neutron str function (as well as R') and on the quadrupole moments, would pe a more accurate estimate of the octupole moments.

539

11306 NUCLEAR RADII FROM NEUTRON SCATTERING.

R.Wilson.

Nuclear Phys., Vol. 16, No. 2, 318-19 (May (1), 1960).

It is shown how determinations of nuclear radii by neutron a electron scattering can be reconciled, with the exception of a pos anomaly for lithium.

53

11307 NUCLEAR POLARIZATION OF Co^{55}.

R.W.Bauer and M.Deutsch.

Nuclear Phys., Vol. 16, No. 2, 264-77 (May (1), 1960).

The angular distribution and linear polarization of the gamma- emitted from 18 hr Co^{55}, polarized at low temperatures in ceriu magnesium nitrate crystals, were measured. The amplitude mi ratios δ(E2/M1) of mixed multipole gamma-transitions in Fe^{55} w determined. With a spin of $\frac{7}{2}$ for Co^{55}, a spin sequence of $\frac{7}{2} \rightarrow \frac{5}{2}$ was found in the main decay in Fe^{55}, and for the 0.935 MeV gam ray a δ of +0.36 ± 0.11. A possible spin sequence $\frac{7}{2} \rightarrow \frac{7}{2} \rightarrow \frac{3}{2}$ in F was eliminated by linear polarization measurements. The ratio the nuclear g-values of Co^{58} and Co^{55} was found from a simultan measurement of the angular distribution of the gamma-rays fro 'o isotopes grown into the same crystals. The magnetic moment Co^{55} is 5.3 ± 0.4 n.m., if the 1.03 MeV beta-branch is predominantly G.T. transition, or 4.6 ± 0.4 n.m., if a pure Fermi transition.

539.14

11308 QUASI-PARTICLES AND COLLECTIVE STATES OF SPHERICAL NUCLEI.

M.Vénéroni and R.Arvieu.
.R. Acad. Sci.(Paris), Vol. 250, No. 12, 2155-7, (March 21, 1960). . French.

Using an approximate form of the Hamiltonian derived in a 'evious article (Abstr. 7453 of 1960) an expression is obtained r the energies of excited states. Under certain conditions one of .ese states exhibits collective properties. A.M.Green

539.14

11309 THE NUCLEAR SURFACE IN AN EXCITED NUCLEUS.

A.M.Lane and K.Parker.
ıclear Phys., Vol. 16, No. 4, 690-7 (June (1), 1960).

Measurements of the alpha-spectra from (p,α) reactions in edium-weight nuclei have suggested that the Coulomb barrier ;ain alpha-particle emission is considerably lower for the excited ıcleus than for the ground state. In an attempt to confirm this ıggestion theoretically the variation of surface diffuseness with ccitation energy was studied by considering a Fermi gas of ıcleons in a semi-infinite potential with a diffuse edge. It is found at the calculated particle density shows very little variation with ıclear temperature. This suggests that the barrier penetrability ıould remain roughly constant uo to 30 MeV. The variation of netic energy density in the nuclear surface was obtained as a by-'oduct of the calculations.

539.14

11310 THE EXCITATION OF COLLECTIVE STATES IN NUCLEI BY SCATTERING OF CHARGED PARTICLES.

I.Drozdov.
h. eksper. teor. Fiz., Vol. 36, No. 6, 1875-81 (June, 1959). In ıssian. English translation in: Soviet Physics—JETP (New York), ol. 36(9), No. 6, 1335-9 (Dec., 1959).

Elastic and inelastic scattering of fast charged particles on ack nonspherical nuclei is investigated in the diffraction approxima-on. The radius of the nucleus and its nonsphericity parameter can determined by comparing the calculations with experimental data.

539.14

11311 RESONANT ABSORPTION OF THE GAMMA-RADIATION FROM THE Ne^{22}(p, γ) Na^{23} REACTION.

.L.Mouton and P.B.Smith.
ıclear Phys., Vol. 16, No. 2, 206-14 (May (1), 1960).

The gamma-rays emitted in the reaction Ne^{22}(p, γ)Na^{23} at $_{p}$ = 637 keV were selectively absorbed in sodium fluoride, using e technique of collision produced Doppler shift. Resonant sorption of the 9.40 MeV gamma-rays occurs at 74.3° with respect the proton beam direction. The instrumental resolution curve as determined by observing the resonant absorption of the 12.33 MeV mma-radiation from the reaction Al^{27}(p,γ)Si^{28} at E_p = 771 keV. The sorption curve for Na^{23} is broader than the measured instrumental ırve and therefore it has been possible to determine directly the tal width of the resonance level as 460 ± 360 eV. From the absorp-on integral, together with this value of the total width, the radiation dth (Γ_{γ_0}) for transitions to the ground state is found to be 7 ± 1.1 eV. This result is in agreement with the value $_0$ = 2.0 ± 0.5 eV, found from a yield measurement. No definite signment of parity can be made on the basis of the partial widths tained.

539.14

11312 NUCLEAR RESONANCE FLUORESCENCE IN Au^{197}.

D.Nagle, P.P.Craig, J.G.Dash and R.R.Reiswig.
hys. Rev. Letters, Vol. 4, No. 5, 237-9 (March 1, 1960).

The Mössbauer effect was investigated for the case of the 77 keV -ray line of Au^{197} using as sources, either the β^- parent Pt^{197} or the ectron capture parent Hg^{197}, the sources being maintained at a mperature of 4°K. The shape of the resonance absorption curve as obtained by measuring the transmission of an Au absorber as a nction of the relative velocity of a Pt^{197} source. This gave a locity half-width of 3.5 ± 0.5 mm/sec. Measurements using sorbers of different thickness yielded values of the effective mperatures Φ for the Au and Pt lattices of 54° and 127°K respecti-ly. The results disagree with the predictions of the simplified ebye model of phonon excitation in solids which would give $\Phi = 2/3\,\theta$, θ being the Debye characteristic temperature. Values of $\theta = 185°$K for Au and 233°K for Pt were assumed in this calculation. The mean lifetime of the 77 keV state was found from these results to be 0.82 ± 0.15 mμsec. The effect of placing the source and absorber atoms in different crystal lattices was also investigated. It was found, for example, that placing the emitting atoms in a lattice which is predominantly Au resulted in strong enhancement of the resonance effect. R.E.Meads

539.14 : 539.2

11313 VARIATION WITH TEMPERATURE OF THE ENERGY OF RECOIL-FREE GAMMA RAYS FROM SOLIDS.

R.V.Pound and G.A.Rebka, Jr.
Phys. Rev. Letters, Vol. 4, No. 6, 274-5 (March 15, 1960).

Owing to second-order Doppler effect, it is anticipated that the frequency of the 14.4 keV γ-ray emitted without recoil by 0.1 μsec Fe^{57} should show a slight dependence on the source temperature given by

$$\frac{\partial\nu}{\partial t} = -\frac{\nu C_L}{2Mc^2},$$

where C_L is the lattice specific heat and M the gram atomic weight of iron. This effect has been detected by measuring the difference in transmission of the γ-rays through a thin enriched Fe^{57} absorber, when a thin Co^{57} source was moved towards and away from it, as a function of the temperature difference between source and absorber. The relative motion was achieved by oscillating the source at 10 c/s using a transducer. The results for the temperature sensitivity were in good agreement with the theory, assuming a Debye temperature for the lattice of 420°K. The sensitivity at room temperature is $(-2.09 \pm 0.24) \times 10^{-15}$ per °C. A temperature difference between source and absorber of 1°C would produce a shift about equal to the expected gravitational red-shift over a vertical distance of 22 metres. R.E.Meads

539.14 : 539.2

11314 TEMPERATURE-DEPENDENT SHIFT OF γ RAYS EMITTED BY A SOLID.

B.D.Josephson.
Phys. Rev. Letters, Vol. 4, No. 7, 341-2 (April 1, 1960).

It is shown that, in the recoil-free emission of γ-rays from nuclei in a crystal lattice, the energy of the emitted radiation is subject to a temperature dependent shift given by $\delta E/E = C_p/2c^2$ per °C where C_p = specific heat. This effect is due to relativistic time dilatation caused by the motion of nuclei. In iron at 300°K it has the magnitude 2.2×10^{-15} per °K and must be taken into account in experiments using resonance absorption to determine the gravitational red-shift. R.E.Meads

539.14

11315 ATTEMPTS TO DETECT RESONANCE SCATTERING IN Zn^{67}; THE EFFECT OF ZERO-POINT VIBRATIONS.

R.V.Pound and G.A.Rebka, Jr.
Phys. Rev. Letters, Vol. 4, No. 8, 397-9 (April 15, 1960).

Unsuccessful attempts to detect resonant absorption of the extremely sharp 93 keV γ-ray from the 9.4 μsec level of Zn^{67} are described. The shift in frequency of the γ-ray due to differences in zero-point energies of the lattice atoms of source and absorber is thought to be the most fundamental effect leading to the failure of these experiments. E.A.Sanderson

539.14 : 530.12

SEARCH FOR THE ANISOTROPY OF INERTIA USING THE MÖSSBAUER EFFECT IN Fe^{57}. See Abstr. 10569

539.14 : 539.12 : 530.12

DETERMINATION OF THE APPARENT WEIGHT OF PHOTONS, USING γ-RAY RESONANT ABSORPTION BY Fe^{57}. See Abstr. 10570

539.14 : 539.12

DEVELOPMENTS IN GAMMA-RAY OPTICS, WITH PARTICULAR REFERENCE TO THE MÖSSBAUER EFFECT. See Abstr. 11134

539.14

11316 THE PROTON SUBSHELL Z = 100.

N.N.Kolesnikov and A.P.Krylova.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 550-3 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 389-9 (Feb., 1960).

It is pointed out that α-decay energies of element 102^{253} and 102^{254} are anomalously high and it is suggested that this may be taken as evidence that at Z = a filling of a subshell or a change in deformation occurs. L.L.Green

539.14

11317 ROTATIONAL STATES OF ODD NUCLEI WITHOUT AXIAL SYMMETRY. A.S.Davy̆dov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1555-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1103-6 (Nov., 1959).

A theory is developed for odd nuclei whose ground state spin is due to the angular momentum $j = \frac{1}{2}$ of the outer electron. The energy of the rotational states is obtained as a function of the parameter γ $(0 \leq \gamma \leq \pi/3)$, which determines the deviation of the nuclear shape from axial symmetry.

539.14

11318 TRANSITION PROBABILITIES BETWEEN THE LEVELS OF THE ROTATIONAL BAND OF NON-AXIAL NUCLEI.
A.S.Davy̆dov and V.S.Rostovskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1788-96 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1275-81 (Dec., 1959).

The energies and the wave-functions of the rotational states $(J \geq 4)$ of non-axial nuclei are calculated, and the reduced probabilities for E2 transitions between these states are derived. Conditions under which the rotational states can be characterized by a quantum number K are ascertained. It is shown that, when the shape of the nucleus deviates from axial symmetry, the interval rule 1-3.3-7-12 observed in the rotational band of axial nuclei is violated. The theory is compared with experiment.

539.14

11319 COUPLING OF NUCLEAR ROTATION AND MOTION OF THE OUTER NUCLEON. A.S.Davydov.
Nuclear Phys., Vol. 16, No. 4, 597-607 (June (1), 1960).

A theory of rotational states of odd mass nuclei is developed for the case when additional coupling between nuclear rotation and motion of the outer nucleon is introduced. The reduced probabilities for E2 and M1 transitions between the rotational states are computed. It is shown that the relative reduced probabilities are uniquely defined by the positions of the energy levels of the nucleus.

539.14

11320 COMPARISON OF ASYMMETRIC QUADRUPOLE ROTOR ENERGY LEVEL PREDICTIONS FOR EVEN NUCLEI WITH EXPERIMENTAL RESULTS.
C.A.Mallmann and A.K.Kerman.
Nuclear Phys., Vol. 16, No. 1, 105-12 (April, 1960).

The asymmetric quadrupole rotor energy predictions, taking into account the interactions of the rotations with the beta-vibrations, are compared with experimental results. The agreement between experiment and theory is good for nuclei with $R_e({}^14+) = = [E_e({}^14+)/E_e({}^12+)] \geq \frac{8}{3}$. Even parity energy levels of nuclei with $R_e({}^14+) < \frac{8}{3}$ are not explained adequately.

539.14 : 539.17

11321 STUDY OF THE 4.46 AND 5.03 MeV STATES IN B^{11} BY THE $B^{10}(d,p)B^{11}$ REACTION AT 4.6 MeV DEUTERON ENERGY. S.Gorodetzky, M.Croissiaux, P.Fintz, J.Samuel, G.Bassompierre, R.Armbruster and P.Chevallier.
C.R. Acad. Sci. (Paris), Vol. 250, No. 17, 2874-6 (April 25, 1960). In French.

The angular distributions of the protons from the reaction $B^{10}(d,p)B^{11}$ (forming the 4.46 and 5.03 MeV excited states of B^{11}) were measured at a deuteron energy of 4.6 MeV. The d—p—γ correlations were also measured at this energy. L.L.Green

539.14 : 539.17

11322 STUDY OF THE 6.76 AND 7.30 MeV STATES OF B^{11} BY THE REACTION $B^{10}(d,p)B^{11}$.
S.Gorodetzky, M.Croissiaux, A.Gallmann, P.Fintz, J.Samuel and G.Bassompierre.
C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3153-5 (May 9, 1960). In French.

The angular distributions of the proton groups corresponding to the formation of B^{11} in the 6.76 and 7.30 MeV states were measured at deuteron energy of 1.25 MeV and an attempt is made to interpret the results in terms of stripping theory. L.L.Green

539.14 : 539.17

11323 LEVELS IN Bi^{210} FROM THE $Bi^{209}(d,p)$ REACTION.
G.B.Holm, J.R.Burwell and D.W.Miller.
Phys. Rev., Vol. 118, No. 5, 1247-56 (June 1, 1960).

Q values and differential cross-sections were measured for nuclear states in Bi^{210} excited by the $Bi^{209}(d,p)$ reaction. A previous unobserved group with $Q = 2.35 \pm 0.03$ MeV has been found, corresponding to a state witn probable proton—neutron assignment($h_{9/2}g_{9/2}$) The observed Q value for this state is in good agreement with the Q value expected for the 1- ground state of RaE. Groups of states wit mean excitation of 0.41, 0.88 and 1.4, 2.02, 2.56, 2.81, 3.15, and 4.03 MeV were found, and neutron assignments of $g_{9/2}$, $i_{11/2}$ $d_{5/2}$, $s_{1/2}$ $g_{7/2}$, $d_{3/2}$, and $(h_{11/2})$ are suggested. A comparison with theoretical calculations by Newby and Konopinski (Abstr. 13638 of 1959) for the $(h_{9/2}g_{9/2})$ group of states gives further support to their observation that a calculation of levels in the neighbourhood of Pb^{208} is far less accurate when the extra-core interaction type is proton—neutron tha when it is neutron—neutron or proton—proton.

539.1

11324 LOW LEVEL OF SOME NUCLEI IN THE $d_{3/2}$—$f_{7/2}$ SHEL
S.P.Pandya.
Progr. theor. Phys., Vol. 19, No. 4, 404-6 (April, 1958).

For previous work see Abstr. 8317 of 1956. Excitation energie of some low states of the nuclei Cl^{35}, A^{37}, Cl^{39} and K^{41} are calculate in the jj coupling scheme, independently of the details of the two-body nuclear interaction. Some experiments are suggested to check the calculations.

539.1

11325 LOW-LYING ENERGY LEVELS OF Cs^{134}.
I.V.Estulin, A.S.Melioransky and L.F.Kalinkin.
Nuclear Phys., Vol. 16, No. 1, 168-74 (April, 1960).

A study is made of the cascade γ-transitions following thermal neutron capture in caesium nuclei. Energy and quantum characteristics of low-lying excited states of Cs^{134} with excitation energy up to 320 keV are determined.

539.1

11326 CONCERNING THE EXISTENCE OF A Σ^-n COMPOUND
E.Gandolfi, J.Heughebaert and E.Quercigh.
Nuovo Cimento, Vol. 13, No. 4, 864-7 (Aug. 16, 1959).

A secondary from a K^- interaction occurring at rest in emulsi was found to decay in flight near the end of its range, the visible decay product being a π^- of (70 ± 1.5) MeV. Measurements of ionization and scattering at various points along the track of the decaying particle show its mass to be nearer to that of the deutero than of the Σ-hyperon. The variations of gap-length and scattering with range gave values of $(3780 \pm 175)\ m_e$ and $(4210 \pm 570)\ m_e$ respectively for the mass of the particle which is interpreted as a Σ^-n hyperfragment. It is pointed out that the occurrence of such hyperfragments in emulsion could affect the apparent value of the Σ-lifetime. E.G.Michaeli

539.

11327 UPPER LIMIT FOR PRODUCTION OF Σ^-n HYPERFRAGMENTS BY K^- CAPTURE IN DEUTERIUM.
O.Dahl, N.Horwitz, D.Miller and J.Murray.
Phys. Rev. Letters, Vol. 4, No. 8, 428-30 (April 15, 1960).

To determine the relative rates for the reactions

$$K^- + d \rightarrow (\Sigma^- n) + \pi^+$$

$$K^- + d \rightarrow \Sigma^- + n + \pi$$

227 events of Σ^- (n) production in a deuterium chamber exposed to the separated 450 MeV/c K^- beam were analysed in detail. The three cases giving best fits when these events are interpreted as examples of the first reaction lead to the conclusion that the fraction of Σ^- leading to the formation of the bound state is < 1%. S.J.St-Lor

RADIOACTIVITY . NUCLEAR DECAY

539.16 : 621.31

11328 RAPID METHODS FOR ASCERTAINING WHETHER ACTIVITY OF A WEAK RADIOACTIVE SAMPLE EX- CEEDS A PREDETERMINED LEVEL.
E.H.Cooke-Yarborough and R.C.M.Barnes.
Proc. Instn Elect. Engrs, Paper 3258 M, publ. July, 1960, 12 pp.

To be republished in Vol. 108B, 1961.

Considers methods of determining whether the mean rate of occurrence of random events, such as radioactive disintegrations, is greater or less than some given tolerance rate. The most efficient method is one which makes this determination in the shortest time and with an acceptably low probability of error. Sequential test procedures minimize the sample size by observing the random process until some terminating conditions is satisfied. The performance of several sequential tests is investigated, with particular reference to conditions encountered in monitoring radioactive contamination on the hands. The most efficient of these tests is shown to be one which measures the difference between the number of events actually observed and the number expected at the tolerance rate. Under conditions likely to be encountered in routine monitoring for radioactivity on the hands this method gives a fivefold saving in time over the method now in use.

539.16

11329 THE RADIATION FIELD OF A RECTANGULAR PARALLELEPIPEDAL SELF-ABSORBING SOURCE.

L.N.Posik.
J. nuclear Energy, Vol. 9, No. 1-4, 250-1 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 470 (1958).

The correction for self-absorption is applied to the case of a γ-source contained within a metal tank of wall thickness sufficient to filter out the soft γ-rays, on the assumption that the active material is distributed uniformly and that self-absorption proceeds exponentially. The integral entering the dose-rate formula is tabulated for six values of μ, the γ-ray absorption coefficient. It is concluded that for large μ, a cube of side 60 cm is closely equivalent to a semi-infinite source. I.C.Demetsopoullos

539.16 : 551.5

11330 DETECTION OF RECENTLY PRODUCED FISSION PRODUCTS IN THE ATMOSPHERE.

W. Anderson, R.E.Bentley, L.K.Burton and C.A.Greatorex.
Nature (London), Vol. 186, 223-4 (April 16, 1960).

Details are given of measurements of fission product-levels of surface air sampled at Sutton, Surrey, since May, 1959. The levels of radioactivity on dust were determined by: a small electrostatic precipitator; a large precipitator; and a membrane filter system. From the results a pronounced, but transitory, increase in activity is apparent, occurring some time during Feb. 28 - Mar. 1, 1960. It is suggested that this is due to the first nuclear weapon test in the Sahara. The identity and concentration of some fission products are given. None of the nuclides was present at a level having biological significance. C.R.Barnaby

539.16

11331 RADIOACTIVITY OF THE ATMOSPHERE DUE TO DISTANT NUCLEAR TEST EXPLOSIONS.

D.H.Peirson, R.N.Crooks, and E.M.R.Fisher.
Nature (London), Vol. 186, 224-5 (April 16, 1960).

Measurements have been made of the concentration in air of fission-product activities (using air samplers in aircraft) at an altitude of 47 000 ft in the lower stratosphere and in a composite sample taken between 1700 ft and 18 000 ft in the troposphere. The samples were analysed for Cs^{137} and Zr^{95}. The concentrations of these isotopes are related to high yield nuclear tests and results are given for the period from the middle of 1956 to the middle of 1959. It is found that: the concentration of Cs^{137} in the troposphere follows a seasonal variation, exhibiting peaks in the spring and troughs in the autumn; the ratio $Zr^{95}:Cs^{137}$ is a useful index of the age or origin of the mixture of fission products, and the proportion of new activity may be calculated from the isotope ratios. C.F.Barnaby

539.16 : 61

ON THE DANGER FROM RADIOACTIVITY ARISING FROM AN UNBROKEN SERIES OF ATOMIC BOMB TRIALS. See Abstr. 10457

539.16

11332 A POSSIBLE METHOD OF IDENTIFYING NEW TRANS-URANIC ELEMENTS.

V.I.Gol'danskiĭ and M.I.Podgoretskiĭ.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 315-17 (July, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 223-4 (Jan., 1960).

A method is proposed for establishing the genetic connection between a parent nuclide A and a longer-lived daughter B. It depends on measuring the mean time interval between successive decays of B$(\bar{\tau}_{BB})$ and between decays of [A + B], $(\bar{\tau}_{AB})$. The correlation between A and B is given by $(\bar{\tau}_{BB} - \bar{\tau}_{AB})/\bar{\tau}_{AB}$. Decays of A and B must be experimentally distinguishable. A.Ashmore

539.16

11333 MEASUREMENT OF THE LIFETIME OF THE FIRST EXCITED STATE OF Ne^{21}.

A.G.Khabakhpashev and E.M.Tsenter.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 991-3 (Oct., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 705-6 (April, 1960).

The lifetime of the first excited level of Ne^{21} was measured with a 50-channel time analyser. The measurements yielded a value $T_{1/2} = (6.2 \pm 6.2) \times 10^{-11}$ sec. A short description of the time analyser is given.

539.16

11334 CONTRIBUTIONS TO THE STUDY OF NUCLEAR SPECTROSCOPY BY THE COINCIDENCE METHOD.

N.Perrin.
Ann. Phys. (Paris), Ser. 3, Vol. 5, No. 1-2, 71-130 (Jan.-Feb., 1960).
In French.

This thesis describes measurements on the radioactive isotopes Rh^{101}, Rh^{102}, Zn^{65}, Se^{75}, In^{114} and Eu^{152}. For these isotopes coincidence measurements on the decay schemes are reported and also measurements of K and L conversion ratios and some angular correlation measurements. Precise measurements of K, L and M conversion ratios for members of the active deposits of thorium and actinium are also reported. L.L.Green

539.16 : 539.17

11335 PRODUCTION OF Mo^{93m} IN THE REACTION Se^{80} $(O^{16}, 3n)$.

A.S.Karamyan, L.I.Rusinov and V.A.Fomichev.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1374-6 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 979-80 (Nov., 1959).

The isomer Mo^{93m} has been obtained in irradiating the separated isotope Se^{80} with O^{16} ions accelerated in a 150 cm cyclotron. The isomer results when three neutrons evaporate from the compound nucleus produced by the complete coalescence of Se^{80} and O^{16} nuclei. The excitation function of this reaction and the absolute cross-section for Mo^{93m} production have been measured.

539.16

11336 ISOMERS IN N = 81 NUCLEI.

K.Kotajima and H.Morinaga.
Nuclear Phys., Vol. 16, No. 2, 231-45 (May (1), 1960).

Two new isomers, Nd^{141m} and Sm^{143m}, were found from (γ,n) reactions on natural neodymium and samarium. Their energies and half-lives as well as those of previously known Ce^{139m} and Xe^{135m} were determined very precisely by careful and repeated measurements. They are

	Energy	Half-life
Nd^{141m}	0.755 ± 0.002 MeV	61 ± 2 sec
Sm^{143m}	0.748 ± 0.003 MeV	64 ± 3 sec
Ce^{139m}	0.746 ± 0.002 MeV	60 ± 2 sec
Xe^{135m}	0.528 ± 0.003 MeV	15.65 ± 0.1 min

Systematic variations of the decay characteristics of these four isomers together with those of Te^{133m} and Ba^{137m} are discussed qualitatively.

539.16

11337 ALPHA-DECAY CONSTANTS OF NON-SPHERICAL NUCLEI.

V.G.Nosov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1580-1 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1122-3 (Nov., 1959).

Expressions are given for the alpha-decay probabilities of non-spherical nuclei, in terms of a quantity w_α which gives the probability of finding an alpha particle in the parent nucleus with the other particles in the ground state of the daughter nucleus. Comparison with experiment enables one to determine the w_α, and a table of values is given. E.J.Squires

539.16

11338 RADIOACTIVE DECAY OF Ac^{227} AND EXCITED LEVELS OF Fr^{223} AND Th^{227}.

G.I.Novikova, E.A.Volkova, L.L.Gol'din, D.M.Ziv and E.F.Tret'yakov.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 928-37 (Oct., 1959).

In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 37(10), No. 4, 663-9 (April, 1960).

Radioactive decay of Ac^{227} was investigated. Alpha-decay of Ac^{227} was studied with an α-spectrometer. A β-spectrometer in conjunction with an α—β-coincidence circuit was employed to study β-decay and the spectra of conversion electrons which accompany α- and β-decay of Ac^{227}. A fine structure was detected in the Ac^{227} α-spectrum. The energies of 7 new lines and the intensities of the corresponding transitions were determined. A number of γ-transitions between levels of the daughter Fr^{223} nucleus were detected. A level scheme for Fr^{223} was constructed. Three levels were detected in the spectrum of Th^{227} which is obtained as a result of β-decay of Ac^{227}. The energies of the levels and the intensities of β-decay to them were measured.

539.16

11339 THE DECAY SCHEME OF THE Bi^{210} ISOMER.

S.V.Golenetskii, L.I.Rusinov and Yu.I.Fillimonov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 560-2 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 395-7 (Feb., 1960).

The decay scheme of RaE has been investigated by $\alpha - \gamma$ coincidence measurements. A revised decay scheme for RaE and Tl^{206} is reported and it is suggested that the isomeric $T_{1/2} = 5.01$ days state of RaE is the ground state of Bi^{210} and not an excited state at 25 keV, as previously suggested by Levy and Perlman (Abstr. 6826 of 1954). L.L.Green

539.16

11340 THE α-SPECTRUM OF Bi^{214} AND REMARKS ON SOME Bi α-EMITTERS.

R.J.Walen and G.Bastin-Scoffier.

Nuclear Phys., Vol. 16, No. 2, 246-63 (May (1), 1960). In French.

Alpha-spectography of Bi^{214}(RaC) shows, beside the two known groups, four other weak ones. Energies and intensities are, in MeV and 10^{-6} units: 5.512(82)—5.448(116)—5.268(12.5)—5.184(1.3)——5.023(0.45)—4.941(0.52). Systematics of hindrance factors of Bi α-emitters suggest a shell-model interpretation of the corresponding levels, which show, for the 208 and 210 isotopes of Tl, the same sesequence of multiplets.

539.16

11341 ALPHA-PARTICLE AND FISSION ANISOTROPIES FROM ORIENTED ACTINIDE NUCLEI.

J.W.T.Dabbs., L.D.Roberts and G.W.Parker.

Physica, Vol. 24, Supplement, S69-S77, (Sept., 1958).

Low Temperature Physics Conference (see Abstr. 7017 of 1960). It is expected that orientation of nuclei having large quadrupole moments, assuming a uniform α-formation over the nuclear surface, should give large anisotropies in α-emission. Use was made of crystalline electric fields acting in the nuclear quadrupole moments to obtain aligned nuclei. The angular distributions from aligned Np^{237} and U^{233} sources give maxima perpendicular to the c-axis while that of U^{234} is isotropic, as expected from an even—even nucleus. The theoretical prediction is that the α-emission should be larger at the nuclear poles. Reasons are suggested for the discrepency between theory and experiment and further experiments to elucidate it are outlined. S.E.Hunt

539.16

11342 MEASUREMENT OF THE ENERGY OF THE WEAK GROUP IN THE α-SPECTRUM OF Po^{210}.

T.Fényes.

Nuclear Phys., Vol. 16, No. 3, 529-33 (May (2), 1960).

The nuclear spectrum of Po^{210} was examined by a scintillation $\alpha - \gamma$ coincidence equipment combined with an electromagnetic α-spectrometer. Accepting 5.3054 ± 0.0010 MeV (absolute V) as the value (Abstr. 3335 of 1958) for the kinetic energy of the main group, that of the weak group was found to be 4.525 ± 0.005 MeV.

539.16

11343 SYSTEMATICS OF ALPHA-RADIOACTIVITY IN THE RARE EARTH REGION.

K.S.Toth and J.O.Rasmussen.

Nuclear Phys., Vol. 39, No. 3, 474-91 (May (2), 1960).

Alpha-decay energy data in the rare-earth region are extended by means of closed decay energy cycle calculations and are then correlated for each element as a function of neutron number. The marked effect of the closed shell at 82 neutrons on the alpha-decay energies is discussed. Evidence is presented for a sharp drop at 90 neutrons in the normal alpha-decay energy versus neutron number trend, as well as for a proton subshell at 64 protons. Half-lives are calculated using a formula derived from simple barrier-penetration theory. The calculated values are compared with experimental half-lives and discrepancies are discussed. Reduced level widths δ^2 are determined for rare-earth alpha-emitters using barrier penetration factors calculated from the real potential derived by optical model analysis of alpha elastic scattering data. The reduced widths are in turn used to propose hindrance factors for odd-mass alpha-emitters.

539.16 : 539.1

11344 ALPHA DECAY OF RdAc ACCORDING TO THE COLLECTIVE MODEL AND THE SPIN OF THE AcX NUCLEUS.

S.G.Ryzhanov.

J. nuclear Energy, Vol. 9, No. 1-4, 111-13 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 80 (1958).

To explain the fact that the relative yield of α-particles going into the 173 keV level in RdAc is twice as high as in the neighbouring levels, it is assumed that energies of single-particle levels of an odd nucleon of spin K in the field of a strongly deformed nuclear core are little different from those of the rotational levels of spin K + 2 and K + 3. The Ter-Martirosyan equation for the probability of α-decay is discussed and its two semi-empirical coefficients α and β are determined from the known energy differences in the levels of the final nucleus. The values obtained for the coefficients are discussed. F.Lachma

539.1

11345 ALPHA SPECTRUM OF THE NATURAL SAMARIUM ISOTOPE MIXTURE.

A.A.Vorob'ev, A.P.Komar, V.A.Korolev and G.E.Solyakin.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 546-8 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New Yor Vol. 37(10), No. 3, 386-7 (Feb., 1960).

Using a gridded ionization chamber the alpha-particle spectru of natural samarium was studied and the energy of the Sm^{147} alpha-particles was measured as 2.19 ± 0.01 MeV, the half-width of the line amounting to 43 keV (including thickness of the source). At this resolution no other groups of alpha-particles were detected. By examining the spectrum in the region of the alpha-particle energy of Sm^{146} (~ 2.55 MeV), it was possible to estimate the isotopic content of Sm^{146} in natural samarium as 2.5×10^{-6}%. R.H.Thoma

539.1

11346 NATURAL RADIOACTIVITY OF SAMARIUM AND NEODYMIUM.

M.Karras and M.Nurmia.

Nature (London), Vol. 185, 601 (Feb. 27, 1960).

A grid-type ionization chamber was used to analyse samples o natural samarium. Calibration was performed with 1.797 and 1.47 MeV alpha-particles. The result for the alpha energy of Sm^{147} was 2.20 ± 0.03 MeV. The specific activity of natural samarium was found to be 7.00 ± 0.3 alpha-particles min^{-1} mg^{-1} which corresponds to a half-life of $(1.14 \pm 0.05) \times 10^{11}$ yr for Sm^{147}. A weak alp energy of 2.0 ± 0.1 MeV was found for a sample of natural neodymi C.F.Barnab

539.

11347 SEARCH FOR THE NATURAL ALPHA ACTIVITY OF TUNGSTEN.

G.B.Beard and W.H.Kelly.

Nuclear Phys., Vol. 16, No. 4, 591-6 (June (1), 1960).

Scintillation properties of $CdWO_4$ and $CaWO_4$ crystals were studied and the crystals used in the search for natural alpha-activi in tungsten. The relative scintillation efficiencies for gammas we found to be nearly the same for the two crystals and equal to appr mately 0.1 times that of NaI:Tl. An external source of 5.3 MeV alp particles produces approximately the same size pulses as 1.7 MeV gammas. The scintillation decay times were found to be 3.3 μsec and 3.9 μsec for $CaWO_4$ and $CdWO_4$, respectively. Background measurements were made with a 3.8 cm diameter × 0.64 NaI:Tl crystal. No indication of an alpha-activity of tungsten was seen. It is concluded that any tungsten alpha-activity present correspond to a half-life of greater than $8\ K \times 10^{17}$ yr, where K is the relativ isotopic abundance of the isotope undergoing decay. This is in disagreement with the previously reported half-life of $2.2 K \times 10^{17}$

539

11348 MEASUREMENT OF THE RELATIVE INTENSITY O TRANSITIONS TO THE FIRST EXCITED STATE OF THE DAUGHTER NUCLEUS IN DECAY OF U^{238} AND U^{234}.

A.A.Vorob'ev, A.P.Komar and V.A.Korolev.

Zh. eksper teor. Fiz., Vol. 37, No. 5(11), 1456-7 (Nov., 1959). In Russian.

A scintillation counter was used in coincidence with an ioniza-on chamber to measure the X-rays accompanying the α-decays, nd so distinguish transitions to the excited state. The measured atio for U^{238}/U^{234} was 0.91 ±.04. For U^{238} this implies an intensity 5.5%.

D.W.L.Sprung

539.16

11349

FORMULAS IN THE FERMI THEORY OF BETA-DECAY. I. BETA-SPECTRUM. Z.Matumoto and M.Yamada.

rogr. theor. Phys., Vol. 19, No. 3, 285-329 (March, 1958).

β-spectra are calculated assuming the Fermi theory. All effects ue to the finiteness of the nuclear size are taken into account in an nalytical form, and screening effects by atomic electrons are ncluded as additional factors through their values are not given xplicitly. The electron wave-functions are calculated and applied o obtain the correction factors for β-spectra. The mixed type inter-ction consisting of scalar, tensor and pseudoscalar is examined in etail. The final formulae are similar to those for light nuclei of onopinski and Uhlenbeck (1941). There is a difference, however, hich lies in the fact that several "effective nuclear radii" are used n the authors' formulae instead of the usual nuclear radius. Special ttention is paid to the errors in these formulae, which seem to be nevitable from the practical view-point, and also to the insensitivity f β-spectra to the nuclear charge distribution.

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11350

NUCLEAR MATRIX ELEMENT RELATIONS IN THE FERMI THEORY OF BETA DECAY. T.Ahrens.

rogr. theor. Phys., Vol. 18, No. 4, 331-44 (Oct., 1957).

A common basis is provided for the formal relations between orbidden nuclear matrix elements. It is shown how numerical esti-ates of the coefficients of proportionality can subsequently be made pon introducing, on the one hand, less,and on the other hand, more, etailed nuclear force characteristics. Coarse structure correction ctors are derived differing from similar ones appearing in the terature. Finally, it is indicated how theoretical nuclear matrix lement ratios may serve in the interpretation of beta spectra.

539.16

11351

NOTE ON THE DECAY OF THE NEW NUCLEIDE Cr^{56}. B.J.Dropesky, A.W.Schardt and T.T.Shull.

uclear Phys., Vol. 16, No. 2, 357-9 (May (1), 1960).

Cr^{56} was identified and was found to decay with a 5.94 min half-ife. A 1.5 MeV β-group and a 26, 83 keV γ-ray cascade were ob-erved in this decay.

539.16

11352

STUDY OF HEAVY ODD-MASS INDIUM ISOTOPES FROM THE (γ,p) REACTION ON TIN.

I.Yuta and H.Morinaga.

uclear Phys., Vol. 16, No. 1, 119-37 (April, 1960).

A series of bombardments using the 25 MeV bremsstrahlung n enriched isotopes $Sn^{120}O_2$, $Sn^{122}O_2$, $Sn^{124}O_2$, and natural tin have esulted in the discovery of new isotopes In^{121}, In^{123}, and their somers. The previously reported activity of In^{119} is assigned to n^{119g}. The results are as follows:

	half-lives	energies of β-rays (MeV)	energies of γ-rays (MeV)
In^{119g}	2.3 min	1.6	0.77
In^{121g}	30 sec		0.94
In^{123g}	10 sec		1.10
In^{121m}	3.1 min	3.7	
In^{123m}	36 sec	4.6	

ecay schemes and level assignments are proposed. All the decay haracteristics fit into shell-model systematics, allowing syste-natic studies of pertinent nuclear properties. Relative yields of hotoreaction on tin are also derived on the basis of these decay chemes.

539.16

11353

INVESTIGATION OF β-RADIATION OF Nb^{95} AND Ce^{144} BY THE ATMOSPHERIC ABSORPTION METHOD,

.E.Tsvetaeva and L.A.Rozenfel'd.

h. eksper. teor. Fiz., Vol. 38, No.2, 641-3 (Feb., 1960). In Russian.

In the absorption method β-ray energies are measured interms f a coefficient K = Io/Ip, where Io is the intensity of β-rays from a ource enclosed in a vacuum and Ip is the corresponding intensity when the vacuum is replaced by air at pressure p (usually 1 atm.). In the β-energy region $Eo < 0.5$ MeV, K increases very steeply for decreasing E and so affords a sensitive method of resolving neighbouring lines in this region. Neighbouring lines of Nb^{95} and Ce^{144} were found by this method to have the following energies:

Nb^{95}, $Eo = 0.166 \pm 0.004$ MeV
Ce^{144}, $Eo = 0.168 \,{}^{+0.032}_{-0.020}$ MeV

J.W.Gardner

539.16

11354

BETA- AND GAMMA-RAY SPECTRA OF Pd^{111}.

W.W.Pratt and R.G.Cochran.

Phys. Rev., Vol. 118, No. 5, 1313-15 (June 1, 1960).

Beta rays of 2.18 MeV and gamma rays of 0.377, 0.580, 0.620, 0.810, 1.380, and 1.450 MeV were found in the decay of the 22 min isomer of Pd^{111}. Beta rays of 2.02 MeV and gamma rays of 0.170 and 1.690 MeV were found associated with the 5.5 hr isomer. Although the beta ray groups may both represent the decay of the 22 min state, the dissimilarity of the gamma-ray spectra implies some degree of beta-ray branching from the 5.5 hr state.

539.16

11355

0^+—0^+ TRANSITION IN THE Pr^{140}—Ce^{140} DECAY.

B.S.Dzhelepov, I.F.Uchevatkin and S.A.Shestopalova.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 857-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 611-12 (March, 1960).

The 1902 keV 0^+ excited state in Ce^{140}, which is excited by the decay of La^{140}, is shown to be excited also by the decay of Pr^{140}. The two β^+-decays from the ground state of Pr^{140} to the 0^+ levels of Ce^{140} are shown to differ in reduced widths by a factor of 100.

L.L.Green

539.16

11356

PARITY NONCONSERVATION AND THE BETA-SPECTRUM OF RaE.

J.Fujita, M.Yamada, Z.Matumoto and S.Nakamura.

Progr. theor. Phys., Vol. 20, No. 3, 287-307 (Sept., 1958).

A method suitable for analysing the anomalous β-spectrum of RaE (Bi^{210}) is developed. It is shown that, if the Gamow—Teller component of the β-decay interaction is of the tensor type, it is very difficult to explain the shape of the β-spectrum of RaE unless all of the following conditions are satisfied simultaneously: (a) the Fermi component is of the scalar type, (b) $C_S/C_S' = C_T/C_T'$, and (c) C_SC_T = real. Alternatively, if the Ganow—Teller component is of the axial vector type, the conditions are: (a) the Fermi component is of the vector type, (b) $C_V/C'_V = C_A/C'_A$, and (c) C_V/C_A= real.

539.16

11357

DECAY OF RUTHENIUM-105.

B.Saraf, P.Harihar and R.Jambunathan.

Phys. Rev., Vol. 118, No. 5, 1289-92 (June 1, 1960).

The decay of Ru^{105} was studied employing two scintillation spectrometers in coincidence. It is found that Ru^{105} decays to the excited levels of Rh^{105} with the emission of six β-groups, with end-point energies of ~125, 525, 915, 1080, 1150, and ~1800 keV, the branching ratios being approximately ~0.002, 0.068, 0.11, 0.30, 0.51, and ~0.01, respectively. The subsequent γ-rays have the energies of 130, 265 320, 400, 475, 485, 665, 725, 875, 960, 1350, and 1750 keV. From γ—γ and β—γ coincidence measurements, a level scheme of Rh^{105} has been worked out, showing the excited states at 130, 395, (or 530), 475, 725, 795, 960, 1350, and 1750 keV.

539.16

11358

ON THE DECAY OF Rh^{106}.

O.J.Segaert, J.Demuynck, A.M.Hoogenboom and H.Van Den Bold.

Nuclear Phys., Vol. 16, No. 1, 138-52 (April, 1960).

The beta- and gamma-radiation following the 30 sec decay of Rh^{106} was investigated with a double-focusing beta-ray spectrometer, single-crystal, coincidence and sum-coincidence gamma-ray spectrometers. Gamma-rays of 0.513, 0.624, 0.87, 0.89, 1.045, 1.14, 1.31, 1.51, 1.55, 1.76, 1.93, 2.13, 2.30, 2.37, 2.44, 2.63 and 2.88 MeV were found in decay of Pd^{106}. Relative intensities of beta- and gamma-rays are reported and a level scheme for Pd^{106} is proposed. Two new levels at 2.02 and 2.88 MeV are added. The intensity measurement of the K and L lines of the 0.513 MeV transition yields a K/LM ratio of 6.15 ± 0.62.

539.16

11359 ON THE DECAY OF Rh^{106m}.

O.J.Segaert and J.L.Demuynck.

Nuclear Phys., Vol. 16, No. 3, 492-501 (May 2, 1960).

The Rh^{106m} nuclide was produced by irradiating Pd with 25 MeV deuterons. The beta- and gamma-radiations following the decaly of 133 ± 4 min Rh^{106m} were investigated with scintillation spectrometers. The Rh^{106m} was found to decay mainly by 790, 950, 1180 and 1629 keV beta-transitions. Gamma-rays of 220, 407, 450, 512, 620, 735, 820, 1055, 1140, 1225, 1560, 1740, 1860, 2120, and 2280 keV were assigned with certainty. Relative intensities of the beta- and gamma-rays are reported. A tentative level scheme is proposed for Pd^{106}.

539.16

11360 NUCLEAR MATRIX ELEMENTS IN THE β-DECAY OF Sb^{124}.

R.M.Steffen.

Phys. Rev. Letters, Vol. 4, No. 6, 290-2 (March 15, 1960).

The $\beta-\gamma$ directional correlation was measured as a function of angle and β energy for the non-unique first-forbidden transition from the spin 3$^-$ ground-state of Sb^{124} to the 2$^+$ first excited state of Te^{124}. These results, combined with those of the circular polarization experiments of Hartwig and Schopper (see following abstract) have yielded absolute values of the matrix elements for the transition, as follows:

$$\left|\int \mathrm{Bij}\right|/R = (1.20 \pm 0.15) \times 10^{-2}$$

$$\left|\int \vec{r}\right|/R = (1.2 \pm 1.2) \times 10^{-3}$$

$$\left|\int i\vec{\sigma} \times \vec{r}\right|/R = (0.1 \pm 0.4) \times 10^{-3}$$

$$\left|\int i\vec{\alpha}\right| = (3.1 \pm 2.4) \times 10^{-4}$$

$$\left(\int i\vec{\alpha} \Big/ \mathrm{Bij}\right) > 0 \quad \text{where } R = \text{nuclear radius.}$$

The large log ft value (10.6) for this transition and the predominance of the Bij term can probably be explained by the selection rule effect suggested by Kotani (Abstr. 10063 of 1959) and by Morita and Morita (Abstr. 2550 of 1958). R.E.Meads

539.16

11361 $\beta-\gamma$ CIRCULAR POLARIZATION CORRELATION OF Sb^{124}.

G.Hartwig and H.Schopper.

Phys. Rev. Letters, Vol. 4, No. 6, 293-5 (March 15, 1960).

See also preceding abstract. The $\beta-\gamma$ circular polarization correlation was measured in the decay of the Sb^{124} ground-state (spin 3$^-$) through the first excited state (spin 2$^+$) of Te^{124}. This first-forbidden transition having end-point energy 2.3 MeV is of interest since it shows deviation from the allowed shape and large $\beta-\gamma$ anisotropy. Such measurements enable unique determinations to be made of the four matrix elements $\int\vec{r}$, $\int i\vec{\sigma} \times \vec{r}$, $\int i\vec{\alpha}$ and Bij contributing to the transition. Actual measurement of the circular polarization of the γ-rays was made by observing forward Compton scattering from a magnetized iron cylinder. It is found that the value of Bij is much larger than that of $\int\vec{r}$ and $\int i\vec{\sigma} \times \vec{r}$ and is of the same order of magnitude as $\int i\vec{\alpha}$. $\int i\vec{\alpha}$ is in phase with Bij. These results are explained only by the "modified Bij approximation". The unusual enhancement of Bij can be explained by the "selection rule effect" discussed by Morita and Morita (Abstr. 2550 of 1958) and Kotani (Abstr. 10063 of 1959). R.E.Meads

539.16

11362 CIRCULAR POLARIZATION OF INTERNAL BREMSSTRAHLUNG ACCOMPANYING β DECAY.

S.Galster and H.Schopper.

Phys. Rev. Letters, Vol. 4, No. 6, 295-6 (March 15, 1960).

Because of non-conservation of parity in β-decay it is expected that photons emitted together with electrons and neutrinos should be circularly polarized. Circular polarization of internal bremsstrahlung would be expected, and this was investigated for the allowed decay of P^{32}, the first-forbidden decay of RaE (Bi^{210}) and the unique forbidden decay of Y^{90}. The circular polarization was detected by the change in forward Compton scattering from a magnetized iron cylinder on reversal of the direction of magnetization. Corrections to the results were required, especially at high photon energies, for the elastic scattering of γ-rays by the iron cylinder, for Compton scattering from the copper magnetizing coil, and for photons penetrating the central lead absorber. Thin sources and backings were used to avoid the production of external bremsstrahlung. The results were compared with the predictions of the theory developed for allowed decays, and the data for P^{32} agreed well. The results for the unique forbidden case of Y^{90} were also in agreement, but those for RaE were consistently lower. Results were also obtained for the longitudinal polarization of the electrons in the above cases. R.E.Meads

539.16 : 539.17

11363 THE HALF-LIFE OF Sr^{90} AND ITS YIELD FROM ^{233}U FISSION.

M.P.Anikina, R.N.Ivanov, G.M.Kukavadze and B.V.Ershler.

J. nuclear Energy, Vol. 9, No. 1-4, 167-8 (June, 1958). English translation from: Atomnaya Energiya, Vol. 4, 198 (1958).

Strontium was chemically extracted from a sample of U^{233} which had been neutron irradiated. The decay of β-activity was followed using a mica-window geiger counter. From measurements of the Sr^{88} and Sr^{90} content by a mass spectrometer the half-life of Sr^{90} was calculated as 29.3 ± 1.6 yrs. The yield from U^{233} fission of Sr^{88} was found to be 5.3 ± 0.3% and 5.8 ± 0.4% for Sr^{90}. R.H.Thomas

539.16

11364 BETA DECAY OF Y^{91}.

O.E.Johnson and W.G.Smith.

Phys. Rev., Vol. 118, No. 5, 1315-18 (June 1, 1960).

The decay of Y^{91} was studied using NaI(Tl) scintillation counters and a 4π beta-ray scintillation spectrometer. A single gamma ray with a measured energy of 1.208 ± 0.010 MeV was observed. The shape and end-point energy of the weak (~0.3%) beta group in coincidence with the 1.208 MeV gamma ray was measured. The end-point energy was determined to be 0.319 ± 0.010 MeV. The experimental shape factor is clearly in disagreement with that predicted for a once-forbidden unique transition, $\Delta I = 2$ (yes). The 0.319 MeV beta spectrum yields a shape factor which may, within experimental accuracy, be interpreted as a statistical shape. These measurements yield a Y^{91}—Zr^{91} mass difference of 1.527 ± 0.014 MeV.

539.16

11365 BETA—GAMMA ANGULAR CORRELATION MEASUREMENTS ON Au^{198}. I. DIRECTIONAL AND CIRCULAR POLARIZATION CORRELATION.

R.M.Steffen.

Phys. Rev., Vol. 118, No. 3, 763-7 (May 1, 1960).

The beta—gamma directional correlation of Au^{198} was measured as a function of the energy of the beta-particles. The anisotropy factor A$_2$(W) in the beta—gamma directional correlation

$$\mathcal{W}_{\beta\gamma}(\theta, W) = 1 + A_2(W)P_2(\cos\theta)$$

is proportional to p^2/W and its value near the maximum beta energy is $A_2(2.8) = 0.029 \pm 0.001$. The beta directional gamma circular polarization correlation of Au^{198} was measured using the backscattering of the circularly polarized gamma radiation from a radially magnetized iron disk. The correlation is of the form:

$$\mathcal{W}_{\beta\gamma\mathrm{pol}}(\theta, W) = 1 + (0.45 \pm 0.07)(p\lambda W)P_1(\cos\theta).$$

The shape correction factor of the first-forbidden beta spectrum is independent of the beta energy above W = 1.6 within 5%. The analysis of the data shows that the ξ-approximation for first-forbidden non-unique beta transitions represents the Au^{198} results in a very satisfactory manner.

539.16

11366 BETA—GAMMA ANGULAR CORRELATION MEASUREMENTS ON Au^{198}. II. TRANSVERSE POLARIZATION OF THE BETA PARTICLES.

P.C.Simms and R.M.Steffen.

Phys. Rev., Vol. 118, No. 3, 768-71 (May 1, 1960).

As a consequence of the nonconservation of parity in beta decay, beta particles emitted in first-forbidden beta transitions exhibit a small degree of polarization transverse to their momentum. The direction of the transverse polarization is defined with respect to a plane which is introduced by observing the direction of emission of the beta particle and the direction of emission of a gamma ray following the beta transition. The degree of the transverse polarization parallel to the beta—gamma plane P_T, and the degree of polarization perpendicular to the beta-gamma plane P_T was measured for Au^{198}. The beta polarization was detected by means of the left-right asymmetry in a Mott scattering process for an average electron energy $W = 2.0\,mc^2$ and for an angle O = 135° between the beta momentum and the gamma direction. The results of the measurements $P_T = +0.011 \pm 0.005$ and $P_T = +0.03 \pm 0.008$, agree satisfactoril with the values calculated on the basis of the ξ approximation from the anisotropy of the Au^{198} beta—gamma directional correlation.

539.16

11367 CLASSIFICATION OF BETA- AND GAMMA-RAY TRANSITIONS BETWEEN INTRINSIC STATES IN DEFORMED EVEN-MASS NUCLEI.

C.J.Gallagher.

Nuclear Phys., Vol. 16, No. 2, 215-30 (May (1), 1960).

The description of intrinsic states of deformed even-mass nuclei by the product wave-functions of the strong coupling model, using Nilsson wave-functions to describe the intrinsic particle configurations, is shown to lead to selection rules which depend on the coupling between the last two particles. In the case in which the coupling in the final and initial states is the same, the description leads, in the asymptotic limit of the Nilsson wave-functions, to selection rules similar to those proposed earlier for odd-mass nuclei. For nuclear states with different relative couplings the selection rules lead most frequently to K-forbiddenness. It is shown that, if the non-transforming particle in the two-particle product wave-function is not the same in the final and initial states, the resulting two-particle transition is formally forbidden. The experimental transition rates in even-mass nuclei to which definite configurations can be assigned are observed to fall within well-defined ranges characteristic of the degree of forbiddenness predicted by the selection rules. Furthermore, the data on log ft-values indicate that single-particle transitions occur with essentially the same speed whether the transforming particle is in an odd-mass or an even-mass nucleus.

539.16

11368 CONVERSION ELECTRON SPECTRUM FROM Ce^{144} DECAY.

J.S.Geiger, R.L.Graham and G.T.Ewan.

Nuclear Phys., Vol. 16, No. 1, 1-26 (April, 1960).

The internal-conversion electron spectrum following the β-decay of Ce^{144} was studied in the Chalk River iron-free $\pi\sqrt{2}\,\beta$-spectrometer at a momentum resolution of ≅ 0.1%. The 33 conversion lines observed are identified with 7 transitions of energies (in keV) and multipolarities 33.57 ± 0.03, M1; 40.93 ± 0.03, M1; 53.41 ± 0.03, M1; 59.03 ± 0.03, M3; 80.12 ± 0.03, M1; 99.95 ± 0.03, E2; and 133.53 ± 0.03, M1. The multipolarity assignment for each transition was obtained by comparing the observed conversion line intensity ratios with the theoretical line intensity ratios of Sliv. The intensity of the K-conversion line of the 133.53 keV transition was measured relative to the total intensity of the Pr^{144} β-spectrum; $I_{K\,133}/I_{Pr\,\beta\,sp.} = 0.053 \pm 0.002$. The momentum ratio of the Ce^{144} K 133.53 and Cs^{137} K 661.6 lines, corrected for electron energy loss in the Ce course, is $B\rho_{K\,133}/B\rho_{K\,661} = 0.31495 \pm 0.00003$. Intensity limits are placed on all previously reported Ce^{144} conversion lines not presently observed. Relative quantum intensities and total transition intensities are deduced from the conversion line data. A decay scheme for Ce^{144} is given which satisfactorily accounts for all the results of this investigation and is compatible with the results of earlier workers when some line reassignments are made. Interpretations of the Pr^{144} levels, established in this work, are discussed in terms of both the shell model and the unified model. With $\delta \sim +0.07$, the unified model accounts for the experimental evidence in a simple but convincing fashion.

539.16

11369 CONVERSION, K-AUGER, AND L-AUGER SPECTRA OF Hg^{199}.

J.C.Nall, Q.L.Baird and S.K.Haynes.

Phys.Rev, Vol. 118, No. 5, 1278-88 (June 1, 1960).

The high resolution of the spectrometer made possible the detailed study of K, L, M, N + O conversion lines and the K- and L-Auger spectra of Au^{199} with tne following results (ω and α are the fluorescence and Auger yields and f is the Coster—Kronig transfer probability): K-Auger lines, $\omega_K = 0.952 \pm 0.003$, KLL : KLX : KXY = = 1.00 : 0.496 ±0.015 : 0.094 ± 0.003, and $KL_1L_1 : KL_1L_2 : KL_1L_3 : KL_2L_2 : KL_2L_3 : KL_3L_3 = 1.00 : 1.32 \pm 0.1 : 0.85 \pm 0.06 : 0.40 \pm 0.03 : 1.28 \pm 0.08 : 0.76 \pm 0.05$; L-Auger lines, LMM : LMX : LXY = 1.00: 0.30 ± 0.03 : 0.015 ± 0.004, and $\alpha_L = 0.590 \pm 0.04$, $\omega_L = 0.410 \pm 0.04$, $\alpha(L_1) = 0.16 \pm 0.02$, $\alpha(L_2) = 0.46 \pm 0.04$, $\omega(L_2) = 0.32 \pm 0.03$, and Coster—Kronig yields, $f(L_2L_3X) = 0.22 \pm 0.04$, $f(L_1L_2X) + f(L_1L_3X) = = 0.74 \pm 0.04$. In addition considerable detail was obtained on the KLX and L-Auger fine structure. The results of all of the known L-Auger yield work since 1952 are tabulated. The conversion line results are compared and combined with those of two other groups to give an optimum set of relative intensities. From these are obtained for the 51-keV transition, $\alpha(L_1) : \alpha(L_2) : \alpha(L_3) : \alpha(M) : \alpha(N) : \alpha(O) = = 1.00 : 0.087 \pm 0.010 : 0.012 \pm 0.007 : 0.212 \pm 0.04 : 0.068 \pm 0.005 : 0.016 \pm 0.001$; 156-keV transition, $\alpha(K) : \alpha(L_1) : \alpha(L_2) : \alpha(L_3) : \alpha(M) : \alpha(N + O) = 1.00 : 0.144 \pm 0.015 : 0830 \pm 0.028 : 0.586 \pm 0.018 : 0.418 \pm 0.017 : 0.107 \pm 0.005$; 209-keV transition, $\alpha(K) : \alpha(L_1) : \alpha(L_2) : \alpha(L_3) : \alpha(M) : \alpha(N + O) = 1.00 : 0.155 \pm 0.005 : 0.029 \pm 0.003 : 0.0085 \pm 0.0003 : 0.050 \pm 0.006 : 0.0130 \pm 0.004$, where α is the internal conversion coefficient. In addition, by use of Rose's tables, the 51-keV transition was determined to be $3.3 \pm 1 \times 10^{-4}$ E2, and the 209-keV transition 0.113 ± 0.01 E2, and the E2 assignment of the 158-keV transition was confirmed to better than 1%. The relative gamma-ray intensities are 209 keV : 51 keV : 158 keV = 1000 : 0.045 ± 0.002 : 4.59 ± 0.23.

539.16

11370 ISOMERIC TRANSITION IN Hg^{199}.

R.Sosnowski, S.Sterliński, J.Topa and J.Żylicz.

Acta phys. Polon., Vol. 18, No. 6, 573-80 (1959).

The spectrum of internal conversion electrons for the isomeric transition in Hg^{199} from the $i_{13/2}$ to the $f_{5/2}$ levels was investigated. The energy of the transition was found to be E = 371/1 ± 3.5 keV and the ratios of the internal-conversion coefficients K:L:(M + N) = = 1 : (0.57 ± 0.09) : (0.12 ± 0.07). It was found from the K:L ratio that the percent admixture of type E5 transitions to the basic M4 did not exceed 11%.

539.16

11371 THE CONVERSION ELECTRON SPECTRUM (LOW ENERGY) AND THE AUGER (L,M,N) SPECTRA EMITTED DURING THE β DECAY OF PROTOACTINIUM 233.

G.Albouy and M.Valadarès.

C. R. Acad. Sci (Paris), Vol. 250, No. 17, 2877-9 (April 25, 1960). In French.

539.16

11372 SPECTRUM OF THE INTERNAL CONVERSION ELECTRONS ACCOMPANYING α-DECAY OF U^{233} AND THE LEVEL SCHEME OF Th^{229}.

E.F.Tret'yakov, M.P.Anikina, L.L.Gol'din, G.I.Novikova and N.I.Pirogova.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 917-26 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol.37(10), No. 4, 656-62 (April, 1960).

The spectrum of internal-conversion electrons emitted by Th^{229} (daughter nucleus of U^{233}) was studied in a β-spectrometer with a toroidal magnetic field in conjunction with an e—α-coincidence circuit. The existence of a rotational band which starts at the ground level of Th^{229} was confirmed. The energies of the rotational levels were determined with better accuracy. Gamma-transitions starting from new levels (29.1, 71.4, 320.0, 366.0 keV and apparently 131.0 keV) were detected and investigated. Some refinements were introduced in the U^{233} α-spectrum. The level scheme of Th^{229} is discussed.

539.16

11373 SEARCH FOR DOUBLE-QUANTUM EMISSION IN THE DECAY OF Xe^{131m}.

T.Alväger and H.Ryde.

Phys. Rev. Letters, Vol. 4, No. 7, 363-4 (April 1, 1960).

Xe^{131m} was chosen as giving a transition of high multipolarity (M4). X-rays from internal conversion were studied in coincidence with γ-rays using two NaI crystals with 180° geometry. Assuming E2 M2 transitions as the explanation of the observed results a ratio of double to single transitions of 2×10^{-3} was obtained, compared with the calculated value of 5×10^{-5} (Abstr. 1366 of 1960). There are, however, considerable uncertainties in the estimate of the experimental ratio.

A.Ashmore

539.16

11374 THE ELECTRIC-OCTUPOLE TRANSITIONS OF NUCLEI.

M.Sano.

Progr. theor. Phys., Vol. 18, No. 3, 223-34 (Sept., 1957).

The j-forbidden electric octupole transitions of nuclei are explained on the basis of configuration mixing. The main contributions to the matrix element of the j-forbidden electric octupole transitions come from a proton transition for odd proton nuclei, and from both proton and surfon transitions for odd neutron nuclei. In the case of a proton transition, the allowed matrix element is of the first order for odd proton nuclei. For odd neutron nuclei, the mixing of proton configuration must be taken into account. The matrix element for a proton transition is of the second order. The allowed matrix element for a surfon transition is also of the second order. The calculations are based upon the perturbation theory. The agreement between the calculated and observed lifetimes are qualitatively good.

539.16

11375 MULTIPOLE MIXING IN ODD MASS SPHEROIDAL NUCLEI.

R.Nakasima, S.Yamasaki and Y.Yoshizawa.
Progr. theor. Phys., Vol. 19, No. 1, 31-42 (Jan., 1958).

The multipole mixing and half-lives of gamma transitions of odd-mass nuclei are studied in the rare-earth region. The relatively large E2/M1 ratios observed in rotational transitions are found to be consistent with the strong coupling model. Many long-life transitions are found between different rotational families. Some of them are explained by using Nilsson's wave functions in spheroidal potential.

539.16 : 539.17

11376 MILLISECOND HALF-LIFE ISOMERS PRODUCED IN REACTIONS INVOLVING 14 MeV NEUTRONS.

V.L.Glagolev, O.M.Kovrizhnykh, Yu.V.Makarov and P.A.Yampol'skii.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1046-57 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36 (9), No. 4, 742-51 (Oct., 1959).

The short-lived γ-radiation produced by pulsed irradiation of 43 elements with 14.5 MeV neutrons was investigated. Nine isomer activities with half-lives ranging from 10^{-3} to 10^{-1} sec were detected in Mg, Al, Ge, As, Y, In, Pb and Bi. The half-lives and γ-ray energies were measured and in some cases the isomer production cross-sections were estimated. Besides the Pb^{207m} and Bi^{208m} activities, all other isomer activities were produced in the neutron reactions for the first time. As a result it has been possible to identify a number of the isomers and to discuss the possible decay schemes.

539.16

11377 MEASUREMENT OF ANGULAR CORRELATION OF γ-CASCADES 298-880 keV AND 298 - 966 keV IN DY^{160}.

M.V.Klimentovskaya and G.Chandra.
Zh. eksper. teor. Fiz., Vol. 38, No. 1, 290-1 (Jan., 1960). In Russian.

The excited state spins and multipolarities of γ-transitions in Dy^{160} were investigated by measuring the angular correlations of the 298-880 and 298-966 keV γ-cascades. The results are in good agreement with those of Ofer (Abstr. 5277 of 1958) except that a 1.8% admixture of M1 radiation is found in the 880 keV transition. It is concluded that the spin of the 1264 keV level is 2. J.A.Evans

539.16

11378 DECAY OF 45-DAY Fe^{59}.

R.L.Heath, C.W.Reich and D.G.Proctor.
Phys. Rev., Vol. 118, No. 4, 1082-6 (May 15, 1960).

The gamma rays following the decay of 45-day Fe^{59} were studied using the techniques of gamma-ray scintillation spectrometry, including γ—γ coincidence and γ—γ directional correlation measurements. In addition to the previously reported 0.192, 1.10 and 1.29 MeV gamma rays, two additional gamma rays having energies of 0.145 and 0.337 MeV were observed. These latter two arise from a state at 1.43 MeV in Co^{59}. All gamma rays were observed to decay with a half-life of 45 ± 5 days. Directional correlation measurements on the 0.14—1.29 MeV and 0.19 ~ 1.10 MeV cascades were performed. The results of these measurements together with the gamma-ray relative intensities, suggest an assignment of $\frac{1}{2}$- to the 1.43 MeV state in Co^{59}.

539.16

11379 ANGULAR CORRELATION OF THE 1.07—1.24 MeV GAMMA CASCADE IN THE DECAY OF Ga^{66}.

M.K.Ramaswamy and P.S.Jastram.
Nuclear Phys., Vol. 16, No. 1, 113-18 (April, 1960).

The angular correlation of the 1.07—1.24 MeV gamma-ray cascade in Zn^{66} following the decay of 68 min Ga^{66} was measured. The Legendre polynomial expansion coefficients were determined to be $A_2 = 0.31 \pm 0.03$ and $A_4 = 0.23 \pm 0.07$. The measured correlation establishes the spin sequence to be 2-2-0, with a quadrupole-dipole mixing ratio δ of $+ 1.8 \pm 0.2$ for the 1.24 MeV gamma-ray. The result of the angular correlation work together with the allowed nature (log ft = 5.7) of the electron-capture decay to the 2.3 MeV level fixes the spin and parity of this level to be 2^+. The results are consistent with the near-harmonic model of Scharff-Goldhaber and Weneser (Abstr. 6390 of 1955) for even nuclei.

539.16

11380 NUCLEAR RESONANCE FLUORESCENCE WITH THE 105 keV E1 TRANSITION OF Gd^{155} USING AN ULTRACENTRIFUGE.

B.I.Deutch, F.E.Metzger and F.J.Wilhelm.
Nuclear Phys., Vol. 16, No. 1, 81-9 (April, 1960).

Resonance fluorescence from the 105 keV level in Gd^{155} was studied with the centrifuge method. Assuming a branching ratio $\Gamma_0/\Gamma = 0.69$ for this E1 transition to the ground state, a mean life $\tau_\gamma = 6.0^{+6}_{-2} \times 10^{-10}$ sec was calculated from the measured resonance scattering at different source velocities. This lifetime and τ_γ of the 87 keV level measured by Vergnes (Abstr. 8525 of 1959) are consistent with the E1 lifetime predictions of the Nilsson model if the 87 keV orbital is $[651\frac{3}{2}]$ and the 105 keV orbital is $[643\frac{5}{2}]$ at a nuclear deformation $\delta \cong 0.26$.

539.16

11381 CERTAIN GAMMA TRANSITIONS IN I^{128} AND IN NEODYMIUM ISOTOPES.

L.F.Kalinkin, A.S.Melioranskii and I.V.Éstulin.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1613 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York). Vol. 36(9), No. 5, 1146-7 (Nov., 1959).

The low energy γ-rays from neutron capture in I^{128} and neodymium isotopes were measured with a NaI monocrystal.

L.L.Green

539.16

11382 ON THE DECAY OF In^{112}.

R.K.Girgis and R.van Lieshout.
Physica, Vol. 25, No. 7, 597-9 (July, 1959).

In^{112} was formed by the (n,2n) reaction from 20 MeV neutrons on 30% enriched In^{113}. Gamma-ray spectra were taken after 10 min irradiation, without chemical separation, and γ-rays from In^{112}, In^{113}, In^{115} and In^{116} were identified. The decay of the 22 min In^{112} isomeric state at 157 keV and its 11 min β^+ ground state were followed over 24 hr, and the β^+ branching and log ft values found, leading to spin 1^+ for the In^{112} ground state. S.E.Hunt

539.16

11383 GAMMA RAYS FROM THE 4.24 MeV STATE IN Mg^{24}.

R.Batchelor, A.J.Ferguson, H.E.Gove and A.E.Litherland.
Nuclear Phys., Vol. 16, No. 1, 38-51 (April, 1960).

The $Mg^{24}(p,p'\gamma)Mg^{24}$ reaction was studied in the proton energy range from 5 MeV to 6 MeV. The yield of 4.24 MeV γ-rays shows two resonances, at 5.24 MeV and 5.72 MeV, corresponding to states in Al^{25} at 7.30 MeV and 7.77 MeV. The total widths of these resonances are 100 ± 20 keV and 340 ± 50 keV. Angular distributions and correlations of the γ-rays from the 4.24 MeV state of Mg^{24} measured at the 5.72 MeV resonance show that the 4.24 MeV state has spin 2. Spins of 1 and 3 are eliminated by the measurements. The spin of the 7.77 MeV state of Al^{25} is most probably $\frac{3}{2}$. The measured branching ratio of the γ-rays from the 4.24 MeV state to the ground and 1.37 MeV states is $(2.9 \pm 0.5):1$ and the E2/M1 amplitude ratio for the 2.87 MeV transition is $+23 \pm 9$. These data give qualitative support to the collective model but there are quantitative disagreements with the detailed predictions for both axially symmetric and asymmetric nuclei.

539.16

11384 AN INVESTIGATION OF THE EXCITED STATES OF Re^{187}.

M.V.Klimentovskaya and P.I.Shavrin.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1360-5 (May, 1959). In Russian English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 967-71 (Nov., 1959).

The excited-state angular momenta and multipole types of the γ-transitions of Re^{187} have been determined by measuring the angular correlation of the 552-134, 480-134, and 72-134 keV γ-cascades. A value of $(2.2 \pm 0.5) \times 10^{-2}$ was obtained for the ratio of the E2 and M1 amplitudes of the radiation mixture $\delta^2 = I(E2)/I(M1)$, in the γ-transition with an energy of 134 keV. The relative intensity of the 552 keV γ-line was determined. The internal conversion coefficient for the K-shell γ-transition with an energy of 134 keV was measured.

539.16

11385 ON THE DECAY OF Ru^{105}.

R.A.Ricci, S.Monaro and R. van Lieshout.
Nuclear Phys., Vol. 16, No. 2, 339-50 (May (1), 1960).

The decay of 4.4 hr Ru^{105} was studied by means of scintillation techniques and with a double-focusing spectrometer. Eight gamma-rays were observed in addition to the isomeric transition from the 30 sec Rh^{105} daughter. This last one was shown to be of E3 character. A decay scheme is proposed which shows similarities to those of neighbouring nuclides. The strong 725 keV gamma-ray does not populate the isomeric state at 129 keV, but leads directly to the 35 hr ground state.

539.16

11386 DECAY OF Te^{131} ($T_{1/2}$ = 30 HOURS).

A.Bedesku, K.P.Mitrofanov, A.A.Sorokin and V.S.Shpinel'.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 314-15 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 221-2 (Jan., 1960).

A magnetic lens spectrometer and a scintillation coincidence spectrometer were used for the investigation. Relative intensities of γ-rays were measured for the energy region above 720 keV. $\beta-\gamma$ and $\gamma-\gamma$ coincidences were used to identify lower energy transitions from Te^{131}. K conversion coefficients were measured for the 780, 850 and 147 keV transitions, and the lifetime of the last one found to be $(8 \pm 1) \times 10^{-10}$ sec. A decay scheme is given based on only the most reliably established data. A.Ashmore

539.16

11387 DETERMINATION OF A 7×10^{-11} SEC HALF-LIFE FOR THE FIRST EXCITED STATE IN THALLIUM 201.

J.Lindskog, E.Bashandy and T.R.Gerholm.
Nuclear Phys., Vol. 16, No. 1, 175-87 (April, 1960).

A half-life $T_{1/2} = (7 \pm 2) \times 10^{-11}$ sec was found for the first excited 330 keV state in Tl^{201}. The measurements were carried out with an electron—electron coincidence spectrometer by means of delayed-coincidence technique. A new method to reduce the influence of energy-dependent instrumental time delays was developed. The $K/L_{I} + L_{II}$ and $L_{I} + L_{II}/L_{III}$ ratios for the 330 keV transition were measured by means of an iron-yoke double-focussing spectrometer. From these measurements the mixing ratio E2/M1 was found to be 2.2 ± 0.4. The transition matrix elements were calculated and are compared with the corresponding matrix elements in Tl^{203}.

539.16

11388 U ENRICHMENT CAN BE CHECKED BY GAMMA-RAY SPECTROMETRY.

L.A.Sarkes and N.L.MacKinnon.
Nucleonics, Vol. 18, No. 3, 107 (March, 1960).

U^{235} in natural uranium can be estimated by measuring the intensity of the 184 keV gammas. Either 1 g solid samples or liquid samples containing 5 mg U can be used. R.D.Smith

539.16

11389 M1-TRANSITION IN V^{51} AND THE SENIORITY QUANTUM NUMBER.

N.N.Delyagin and M.Preisa.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1586 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1127 (Nov., 1959).

The lifetime of the 321 keV states in V^{51} was measured by a γ-ray resonance scattering method. The measured lifetime is discussed in terms of seniority forbiddenness. L.L.Green

539.16

11390 DIRECTIONAL CORRELATION OF THE GAMMA RAYS IN W^{182}.

G.D.Hickman and M.L.Wiedenbeck.
Phys. Rev., Vol. 118, No. 4, 1049-53 (May 15, 1960).

Directional correlation measurements were performed on seven cascades involving the gamma rays in W^{182}. The angular momenta of the excited states and the character of the transitions which were determined by the correlation measurements are in good agreement with the values as determined by previous investigators. There is evidence for the existence of three rotational bands with the possibility of a fourth band in W^{182}. The nature of these rotational bands is explained in terms of the Bohr—Mottelson model for spheroidal nuclei. The levels are characterized by the quantum numbers (K, I, π). After correction for X-ray interference the 1.222—0.068 MeV correlation results in a spin of 3 to the 1.290 MeV level. The 0.068 MeV gamma ray is essentially pure dipole radiation. The results of the 1.231—0.100 MeV correlation are in good agreement with spin 3 to the 1.331 MeV level with a quadrupole content of $2 \pm 0.5\%$ for the 1.231 MeV radiation. The 0.152—1.222 MeV correlation is only in agreement with an assignment of spin 3 to the 1.374 MeV level with a quadrupole content of less than 0.5% for the 0.152 MeV transition. The 0.152—1.222 MeV correlation yields a quadrupole content of (3-11% or 94-99%) for the 1.122 MeV transition. The 0.222—1.231 MeV, 0.264—1.222 MeV correlations are in good agreement with the assignment of spin 4 to the 1.554 MeV level. However, spins of 3 or 5 for the 1.554 MeV level are also in agreement with the correlation data.

NUCLEAR REACTIONS

539.17

11391 NOTE ON THE COLLISION MATRIX FOR THE NUCLEAR REACTIONS. I.

M.Kawai and M.Nagasaki.
Progr. theor. Phys., Vol. 19, No. 1, 77-92 (Jan., 1958).

The relation between the general theory of nuclear reactions due to Kapur and Peierls (Abstr. 2395 of 1938) and that due to Wigner and Eisenbud (Abstr. 2610 of 1947) is discussed. It is shown that the exact transformation of the R-matrix into the collision matrix yields the expression for the latter which is identical term by term with that obtained by Kapur and Peierls. The intuitive interpretation of the transformation procedure is given in terms of the "multiple reflection interpretation".

539.17

11392 THE NUCLEAR INTERACTION IN THE SCATTERING OF CHARGED PARTICLES FROM NONSPHERICAL NUCLEI.

A.D.Piliya.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1393-7 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 992-4 (Nov., 1959).

The nuclear interaction in the scattering of charged particles with energies close to the height of the Coulomb barrier from black, nonspherical nuclei is considered.

539.17

11393 RESONANCE EFFECTS IN THE SCATTERING OF PARTICLES NEAR A REACTION THRESHOLD.

A.I.Baz'.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1762-70 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36 (9), No. 6, 1256-62 (Dec., 1959).

The energy dependence of the cross-section for the scattering X(aa) X near the threshold E_{th} of the reaction X(ab) Y (X, a, b, Y are arbitrary particles) is studied on the assumption that there are long-range attractive forces between particles b and Y. It is shown that, if these forces are capable of producing bound states of the particles b + Y, there are resonances in the scattering cross-section. These resonances lie below the threshold of the reaction X(ab) Y. A detailed study is made of the case in which attractive Coulomb forces act between b and Y. For this case the number of resonances in infinite, and the density of the resonances approaches infinity as the threshold is approached from below.

539.17

11394 EXCITATION OF NUCLEAR VIBRATIONAL AND ROTATIONAL STATES IN THE SCATTERING OF CHARGED PARTICLES.

E.A.Romanovskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 83-91 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 59-64 (Jan., 1960).

A semi-classical method is used to calculate the inelastic scattering cross-section of heavy charged particles scattered by nuclei having excited rotational and vibrational states. C.J.Batty

539.17

11395 ANGULAR CORRELATIONS NEAR MULTIPLE PRODUCTION THRESHOLDS.

A.F.Grashin.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1480-4 (May, 1960). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36 (9), No. 5, 1049-51 (November, 1959).

Limiting angular correlations near threshold are found for reactions that have as their final products an infinitely heavy nucleus and two, three or four, identical fermions with spin $\frac{1}{2}$.

C.J.Batty

539.17 : 523.877

11396 PYCNONUCLEAR REACTIONS AND NOVA EXPLOSIONS.

A.G.W.Cameron.
Astrophys. J., Vol. 130, No. 3, 916-40 (Nov., 1959).

At very high densities, electron shielding cuts off nuclear coulomb potential barriers quite close to the nuclear surface. Under these circumstances the classical turning points of low-energy ions are very insensitive to the bombarding energy. Nuclear reaction rates thus become very insensitive to temperature but very sensitive to density; such nuclear reactions may be called "pycnonuclear reactions". Nuclear reaction rates as functions of temperature and density have been calculated by double numerical integration of the barrier penetration probability as a function of bombarding energy for the following reactions: $3He^4 \rightarrow C^{12}$, $C^{12}(\alpha, \gamma)O^{16}$, $N^{14}(\alpha, \gamma)F^{18}(\beta^+ \nu)O^{18}$, and $O^{16}(\alpha, \gamma)Ne^{20}$. Pycnonuclear reaction rates for low temperatures and high densities have been calculated for reactions of the following heavy ions with themselves: C^{12}, O^{16}, Ne^{24}, Mg^{32}, Si^{38}, S^{44}, A^{50} and Ca^{56}. It is suggested that after helium energy sources have ceased operating in advanced evolutionary stages of old population I and population II stars, the helium may become highly degenerate and helium pycnonuclear reactions may ignite an explosion. This may account for some of the nova explosions.

539.17 : 539.16

11397 CIRCULARLY POLARIZED GAMMA RAYS FROM DIRECT NUCLEAR REACTIONS. G.R.Satchler.

Nuclear Phys., Vol. 16, No. 4, 674-82 (June (1), 1960).

The residual nuclei following a reaction are left in a polarized state in general. One way of measuring this polarization is to observe any γ-rays the residual nucleus emits. Their angular distribution reveals the even moments of the polarization while their circular polarization depends upon the odd moments. Following a general discussion of circular polarization, and the predictions of the direct interaction picture of nuclear reactions, simple cases of stripping reactions and inelastic scattering are considered. Valuable information can be obtained concerning both the reaction mechanism and the reduced widths and nuclear spins involved.

539.17

11398 DEUTERON PRODUCTION BY NUCLEONS BOMBARDING ATOMIC NUCLEI. K.Kikuchi.

Progr. theor. Phys., Vol. 18, No. 5, 503-40 (Nov., 1957).

Using the general theory of nuclear reactions developed by Ui, (Abstr. 6565 of 1957), the transition matrix is written as the sum of two elements, which correspond to the compound and the non-compound nuclear processes. In the processes proceeding through the compound nucleus, the indirect pickup process, in which a neutron emerging from the compound nucleus picks up any proton, gives a larger yield than the deuteron evaporation in the usual sense. The average kinetic energy of deuterons thus produced is about three times larger than that in the Maxwellian type. In the direct pickup process of low energy (p, d) reaction, the Coulomb effect is found to play an important role and the remarkable backward maximum in the angular distribution of the reaction product is predicted. Direct pickup process at moderate and high energies is calculated by the Born approximation, assuming the Gaussian momentum distribution for sharp energy deuteron groups corresponding to the ground state and the low-lying levels is interpreted in terms of the direct taking place in the external region of the target nucleus. In the limiting case of the weak coupling, which is an appropriate approach to the high energy reaction, the calculation is performed according to the Chew—Goldberger procedure on the basis of the non-degenerate Fermi gas model and the total cross-section is found to obey an approximately 1/v law. Further, the production cross-section of ^1s deuterons is evaluated in the same way, and is found to give a contribution comparable to the production of deuterons in the ground state.

539.17 : 539.14

INELASTIC SCATTERING OF PROTONS. See Abstr. 11288

539.17

11399 APPLICATION OF THE POTENTIAL BARRIER CRITERION TO A STUDY OF DISINTEGRATIONS IN NUCLEAR EMULSIONS. P.I.Fedotov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 944-9 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 674-7 (April, 1960).

Disintegrations induced by 660 MeV protons in carbon embedded as small diamond particles in nuclear emulsions, and disintegrations of light (C, N, O) and heavy (Ag, Br) emulsion nuclei produced by protons of the same energy were studied. An analysis of the carbon disintegrations shows that there is no significant difference in the mechanism of formation of stars containing or not containing an α-particle ($R \leq 50\ \mu$). The relative proportion of Ag and Br disintegrations to those of C, N and O nuclei, chosen by the potential barrier criterion, is 19%.

539.17

11400 THE INTERACTION OF 9 BeV PROTONS WITH EMULSION NUCLEI. N.P.Bogachev, Van Shufen, I.M.Gramenitskii, L.F.Kirillova, R.M.Lebedev, V.B.Lubimov, P.K.Markov, Iu.P.Merekov, M.I.Podgoretskii, V.M.Sidorov, K.D.Tolstov and M.G.Shafranova.

J. nuclear Energy, Vol. 9, No. 1-4, 178-82 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 281 (1958).

The mean free path for nuclear interactions was found to be 34.7 ± 1.5 cm, based on 649 events. The average number of fast particles per event was 3.4 ± 0.1. Frequency and angular distributions are also given. E.J.Burge

539.17 : 539.14

11401 PROTON ELASTIC SCATTERING POLARIZATION AS A TEST OF THE LOW ENERGY OPTICAL MODEL.

A.Strzałkowski, M.S.Bokhari, M.A.Al-Jeboori and B.Hird.

Proc. Phys. Soc., Vol. 75, Pt 4, 502-9 (April 1, 1960).

The polarization produced in the elastic scattering of protons from carbon was measured at several scattering angles using a bombarding energy of 9.4 MeV. This was compared with an optical-model calculation of Bjorklund and Fernbach. At 40° scattering angle the energy dependence of the polarization was measured. It was found to vary smoothly with energy down to 7.5 MeV. The polarization from proton scattering by copper at 35°, 45° and 55°, at an average scattering energy of 6.8 MeV was also measured.

539.17

11402 ON THE CROSS-SECTION FOR COMPOUND NUCLEUS FORMATION BY CHARGED PARTICLES. A.D.Piliya.

Zh. eksper. teor. Fiz., Vol. 137, No. 2(8), 583-5 (Aug., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 2, 413-14 (Feb., 1960).

A closed expression giving the cross-section for compound nucleus formation by charged particles, of energy less than that of the Coulomb barrier, is derived. C.J.Batty

539.17

11403 RADIOCHEMICAL STUDIES OF THE (p,pn) REACTION IN COMPLEX NUCLEI IN THE 80-450 MeV RANGE.

H.P.Yule and A.Turkevich.

Phys. Rev., Vol. 118, No. 6, 1591-8 (June 15, 1960).

Excitation functions for the (p,pn) reaction were determined in the energy range 82 to 426 MeV for the target nuclei F^{19}, Cu^{65}, and Au^{197}. The absolute values are based in the excitation functions for the reaction $C^{12}(p,pn)C^{11}$. These excitation functions exhibit a genera decrease with energy and the cross-sections lie between 122 mb for Au^{196} at 82 MeV and 23 mb for F^{18} at 426 MeV. An excitation functior for the reaction Al^{27} $(p,3pn)Na^{24}$ is also presented. The results of Monte Carlo nuclear cascade calculations were used to predict these (p,pn) excitation functions. The theoretical results are compared wit these and other experimental results. Agreement is obtained for the $F^{19}(p,pn)F^{18}$ excitation function and an extrapolation of the Monte Carlo results. The theoretical excitation functions are about one-half the experimental results of the $Cu^{65}(p,pn)Cu^{64}$ reaction and about one-third the experimental results for $Au^{197}(p,pn)Au^{196}$. The effects on the Monte Carlo calculations of a variation in the radius paramete are examined.

539.17

11404 FURTHER INTERPRETATION OF A MEDIUM ENERGY (p,2p) EXPERIMENT.

A.J.Kromminga and I.E.McCarthy.

Phys. Rev. Letters, Vol. 4, No. 6, 288-90 (March 15, 1960).

The momentum transfer observed in the 40 MeV (p,2p) angular correlation experiment of Griffiths and Eisberg (Abstr. 11464 of 1959) was interpreted by McCarthy, Tezak and Kromminga (Abstr. 11465 of 1959). Further consideration of the regions of the nucleus likely to contribute shows that reactions are most likely to be observed in which the struck particle is moving tangentially. For particles in higher shell model states localized near the surface, tangential components of momentum are much less than radial components. This leads to a better understanding of the experimental angular correlation curve. A.Ashmor

539.17

11405 THE INDIRECT (p,d) PROCESS.

H.Hagiwara and M.Tanifuji.

Progr. theor. Phys., Vol. 18, No. 1, 97-100 (July, 1957).

The effect of secondary nucleons in producing deuterons by th usual pick-up process is calculated. The probability of a secondary nucleon giving rise to a deuteron is expressed approximately in terms of the normal pick-up cross-section, and the deuteron mean-free-path. In conjunction with the experimentally known cross-secti for producing secondary nucleons this allows the computation of the energy spectrum and differential cross-section for indirect deuteron production. The results are in fair agreement with experimental observations at large angles. E.J.Squires

539.17

11406 A MODEL FOR THE INELASTIC SCATTERING OF NUCLEONS.

S.Okai.

Prog. theor. Phys., Vol. 17, No. 2, 308-10 (Feb., 1957).

In order to explain features of the inelastic scattering of 16 and 18 MeV protons from silver which are inexplicable by the statistical theory of nuclear reactions, a new model is proposed. It is suggested that single-particle resonances in the compound system may play an important part in the inelastic scattering of nucleons by nuclei. R.H.Thomas

539.17

11407 SOME CROSS SECTIONS FOR THE PRODUCTION OF RADIO-NUCLIDES IN THE BOMBARDMENT OF C, N, O, AND Fe BY MEDIUM ENERGY PROTONS.

M.Honda and D.Lal.

Phys. Rev., Vol. 118, No. 6, 1618-25 (June 15, 1960).

Measurements were made, using the Berkeley 184 in. cyclotron, to assist in the interpretation of the data on cosmic-ray-produced nuclides in the atmosphere and in iron meteorites. Cross-sections of H^3 and Be^7 were measured in bombardments of organic targets containing nitrogen and oxygen by protons of energy 225-730 MeV. Semicarbazide (CH_5N_3O) targets were used to obtain cross-sections in air nuclei. The targets were prepared by mixing with a few percent of aluminium dust to permit reliable monitoring of the beam. Polyethylene, aluminum lactate, and Plexiglas targets provided elementary cross-sections in carbon and oxygen. Cross-sections were also measured for the production of the long-lived isotopes Cl^{36} (3×10^5 yr) and Al^{26} (8×10^5 yr) at 730 MeV, and of a number of short-lived radionuclides at 500 and 730 MeV, in iron bombardment by protons. These data and those of earlier workers suggest some modifications in empirical relations used for predicting spallation cross-sections in the case of nuclides close to stability. See also Abstr. 11282 of 1960).

539.17

11408 YIELD OF RARE-EARTH ELEMENTS FROM THE SPOLLATION OF BISMUTH BY 660 MeV PROTONS.

A.V.Kaliamin, A.N.Murin, B.K.Preobrazhenskii and N.E.Titov.

J. nuclear Energy, Vol. 9, No. 1-4, 165-7 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 196 (1958).

Reports the formation cross-sections measured for rare earths produced from the spollation of Bi^{209} by 660 MeV protons. From the results quoted and previous measurements the yield curve is shown to be an exponential function of the mass number, of the form: $\text{Log}\ \sigma = pA + \text{constant}$, with $p = 0.11$. R.H.Thomas

539.17

11409 INELASTIC SCATTERING OF HIGH-ENERGY PROTONS EXCITING A COLLECTIVE LEVEL OF NUCLEUS.

K.Nishimura.

Phys. Rev., Vol. 118, No. 5, 1350-2 (June 1, 1960).

An analysis is made of the angular distribution and polarization of 185 MeV protons inelastically scattered by carbon. A rough calculation using the distorted wave Born approximation shows, even though the quantitative agreement is poor, that the 4.4 MeV level of C^{12} may be interpreted as a collective state.

539.17

11410 $(p,p'\gamma)$ ANGULAR CORRELATIONS AT LOW ENERGY.

H.J.Hausman, G.F.Dell and H.F.Bowsher.

Phys. Rev., Vol. 118, No. 5, 1237-46 (June 1, 1960).

At an incident proton bombarding energy of 6.5 MeV, angular correlations were measured between protons scattered inelastically from various even—even nuclei and the decay gamma rays from the first excited states of these nuclei. Among the angular correlation experiments reported are $C^{12}(p,p'\gamma)$ 4.4 MeV, $Ne^{20}(p,p'\gamma)$ 1.63 MeV, $Si^{28}(p,p'\gamma)$ 1.78 MeV, and $S^{32}(p,p'\gamma)$ 2.25 MeV, which were done for proton detector angles of 60°, 90°, and 120°. The measured angular correlation functions are all of the form $A + B\,[\sin^2 2(\theta-\theta_0)]$, where θ_0 is the axis of symmetry. None of the symmetry directions agreed with predictions of the simple direct-reaction theories. However, the symmetry direction for the correlation functions changed with proton detector angle for the experiments on C^{12}, Ne^{20}, and S^{32}; for the experiment on Si^{28} the angular correlation functions were symmetric about 90°, independent of proton detector angle. The results of the angular correlation experiments appear to be consistent with a collective interaction involved in these direct-type reactions than a nucleon—nucleon type collision at the nuclear surface.

539.17

11411 POLARIZATION OF 9 MeV PROTONS ELASTICALLY SCATTERED FROM MAGNESIUM.

A.B.Robbins and G.W.Greenlees.

Phys. Rev., Vol. 118, No. 3, 803-7 (May 1, 1960).

The polarization as a function of angle was measured for protons elastically scattered from a 1 MeV thick magnesium target with a mean energy of 9.1 MeV. The resulting polarization distribution is compared to a differential cross-section measurement with the same target.

539.17

11412 RESONANCE ENERGIES FOR PROTON CAPTURE. II. SODIUM.

S.Wagner and M.Heitzmann.

Z. Naturforsch., Vol. 15a, No. 1, 74-8 (Jan., 1960). In German.

For Pt I, see Abstr. 4907 of 1960. The resonance energies for the $Na^{23}(p,\gamma)Mg^{24}$ reaction were determined between 250 and 745 keV using the resonances at 504.5 and 506.5 keV of the $Al^{27}(p,\gamma)Si^{28}$ reaction as calibration points. S.J.St-Lorant

539.17

11413 THE CROSS-SECTION OF $^{20}Ne(p,\gamma)\,^{21}Na$.

G.C.Thomas and N.W.Tanner.

Proc. Phys. Soc., Vol. 75, Pt 4, 498-501 (April 1, 1960).

The integrated cross-section of the 1170 keV resonance of $Ne^{20}(p,\gamma)^{21}Na$ was measured by counting Na^{21} positron activity following the proton bombardment of a neon gas target. Assuming $\Gamma_p \gg \Gamma_\gamma$, $\omega\Gamma_\gamma = 1.13 \pm 0.07$ eV is found for the resonance. Using this result as a calibration for previous work on the non-resonance capture process in $Ne^{20}(p,\gamma)Na^{21}$ a value for the cross-section parameter S (used for describing nuclear reactions in stars) of 40 keV barns is obtained.

539.17

11414 GROUND-STATE Q VALUES FOR THE $Si^{30}(p,\alpha)Al^{27}$ AND $O^{16}(p,\alpha)N^{13}$ REACTIONS.

R.E.White and W.W.Buechner.

Phys. Rev., Vol. 118, No. 5, 1331-2 (June 1, 1960).

Alpha-particle groups observed during the magnetic analysis of charged particles produced in the bombardment of silicon dioxide targets with 8 and 8.59 MeV protons were identified as arising from the reactions $Si^{30}(p,\alpha)Al^{27}$ and $O^{16}(p,\alpha)N^{13}$. The corresponding Q values are -2.366 ± 0.010 and -5.206 ± 0.010 MeV, respectively.

539.17 : 539.14

11415 COULOMB EXCITATION OF BETA- AND GAMMA-VIBRATIONAL STATES IN Sm^{152}.

R.K.Sheline, H.L.Nielsen and A.Sperduto.

Nuclear Phys., Vol. 16, No. 3, 518-28 (May (2), 1960).

A Sm^{152}-target made by electromagnetic isotope separation was bombarded with 7.5-8.5 MeV deuterons and 8.6 MeV protons. Inelastic scattered groups corresponding to Coulomb excitation of the level at 122 keV were observed in every case, and in one run with 8.5 MeV deuterons Coulomb excitation of levels at 807 keV and 1079 keV was found. The reduced transition probabilities to these states were measured as 4.1 ± 0.1, 0.07 ± 0.02 and 0.12 ± 0.02 respectively, in units of $e^2 \times 10^{-48}\ cm^4$. The reduced transition probabilities for the two highest excited states are several times the single-particle values. This is a strong indication of the collective nature of both these states. Accordingly, these levels are interpreted as beta- and gamma-vibrational states. The partial lifetime and the nuclear strength parameter for the E0-transition between the 807 keV and the 122 keV levels were calculated from the experimental data and are found to be in poor agreement with the theoretical values.

539.17

11416 GAMMA RAYS FROM DEUTERON STRIPPING REACTIONS.

G.R.Satchler and W.Tobocman.

Phys. Rev., Vol. 118, No. 6, 1566-74 (June 15, 1960).

The distorted-wave Born approximation is used to calculate the p—γ angular correlation from several deuteron-stripping (d,p) reactions. One $l = 2$ and four $l = 1$ captures are considered.

Optical potentials with rounded edges are used to distort the wave-functions. In some cases the correlation is considerably changed from the pattern predicted by the plane wave Born approximation, and the distortion effects are strongly dependent on the direction of the emitted proton, and on the type of distortion assumed. The theory of the (d,pγ) correlation is discussed.

539.17

11417 COMPARISON OF THE DIFFERENTIAL CROSS-SECTIONS FOR THE (d,p) AND (d,t) REACTIONS.

A.B.Kurepin and V.G.Neudachin.

Zh. eksper. teor Fiz., Vol. 36, No. 6, 1725-30 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1229-33 (Dec., 1959).

The (d, t) reaction is considered as a special case of a stripping reaction involving two complex systems. The reduced widths derived from the (d, t) and (d, p) reactions by choosing various triton wave-functions are compared. The neutron wave-function relative to the deuteron in the triton, which yields the best agreement with experiment is found. A value of $\cong 0.40$ is derived for the probability of finding the triton in the (deuteron + neutron) state.

539.17 : 539.14

THE B^{10}(d,p)B^{11} REACTION. See Abstr. 11321-2

539.17 : 539.14

LEVELS IN Bi^{210} FROM THE Bi^{209}(d,p) REACTION. See Abstr. 11323

539.17

11418 ANGULAR DISTRIBUTION OF NEUTRONS FROM C^{13}(d,n)N^{14}.

T.L.Abelishvili, T.G.Gachechiladze and O.M.Mdivani.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 631-3 (Feb., 1960). In Russian.

Calculations have been carried out for transitions to the lowest four levels of N^{14}. The amplitude is split into ordinary and "heavy particle" stripping. Agreement with experimental results is obtained by including spin—flip and exchange contributions.

D.W.L.Sprung

539.17

11419 THE ELASTIC SCATTERING OF 19 MeV DEUTERONS BY KRYPTON AND XENON.

J.B.A.England, R.McKeague and P.E.Hodgson.

Nuclear Phys., Vol. 16, No. 1, 52-8 (April, 1960).

Experimental measurements of the elastic differential cross-sections for the scattering of 19 MeV and 19.5 MeV deuterons from krypton and xenon were made using a nuclear emulsion plate camera. The results are compared with calculations using the optical model of the nucleus. The values of the parameters giving the best fit to the experimental results and the sensitivities of the calculated reaction cross-sections to these parameters are discussed.

539.17

11420 ANALYSIS OF (d,t) PICK-UP REACTIONS.

A.I.Hamburger.

Phys. Rev., Vol. 118, No. 5, 1271-8 (June 1, 1960).

A comparison is made between (p,d) [or (d,p)] and (d,t) pick-up reactions involving transitions between the same nuclear levels. Eleven cases are studied, having transfer orbital angular momentum = 0, 1 or 2, for nuclei from Li^{6} to Mg^{25} (also Sn^{117}), and for incident energies of the order of 15 MeV. It is found that if the differential cross-sections of the corresponding (d,p) and (d,t) reactions are plotted as functions of momentum transfer the curves differ by a factor independent of angle. This property holds primarily in the region of the first peak of the angular distribution. Towards larger angles the curves differ in shape. Because of the proportionality between the curves in the forward direction, it is possible to obtain an expression for extracting the stripping reduced width of (d,t) reactions. This reduced width corresponds to the reduced width of the same transition when studied by a (d,p) process. No emphasis is placed on the interpretation of the results in terms of the structure of the triton. An attempt is made to determine the triton momentum transform directly from an analysis of the d + d → p + t experiments, considering these as stripping reactions. It was not possible to apply the curves thus obtained to the (d,t) reactions in the heavier nuclei. The experiment F^{19}(d,t)F^{18} ground state was performed with 14.8-MeV deuterons for angles θ_{lab} between 5° and 45°. The results extend the information about transitions with = 0.

539.17

11421 ANGULAR DISTRIBUTIONS IN THE REACTIONS Ne^{22}(d,p)Ne^{23} AND A^{36}(d,p)A^{37}.

V.G.Sukharevskii.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1377-80 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 981-3 (Nov., 1959).

Thick nuclear emulsions were used to study the angular distributions of protons from (d,p) stripping reactions initiated by 4 MeV deuterons in gaseous targets enriched with Ne^{22} and A^{36}. It was established that the orbital angular momenta of the neutron captured into the ground and first (0.98 MeV) excited states of N^{23} are 2 and 0 (shell model configuration $(1d_{5/2})^{-1}$ and $(2s_{1/2})^{-1}$), while in A^{37} the orbital angular momentum of the neutron in the ground state is 2 — corresponding to a configuration $(1d_{3/2})^{-1}$.

539.17

11422 AN INVESTIGATION OF SOME (^{3}He,α) REACTIONS ON LIGHT NUCLEI AT 5.2 MeV.

I.J.Taylor, F.deS.Barros, P.D.Forsyth, A.A.Jaffe and S.Ramavataram.

Proc. Phys. Soc., Vol. 75, Pt 5, 772-80 (May, 1960).

The reactions B^{11}(He^{3}, α)B^{10}, B^{10}(He^{3}, α)B^{9}, N^{14}(He^{3}, α)N^{13}, O^{16}(He^{3}, α)O^{15} and Al^{27}(He^{3}, α)Al^{26}, were investigated at an incident energy of 5.2 MeV, using a broad-range magnetic spectrograph. Angular distributions and absolute cross-sections for alpha-particles leading to the ground states and several excited states of the final nuclei were measured. The angular distributions of many of the alpha-particle groups suggest the predominance of a direct interaction mechanism for these reactions, and in several cases features which are indicative of a pick-up process are mentioned.

539.17

11423 A STUDY OF THE ^{9}Be(^{3}He,p)^{11}B AND THE ^{9}Be(^{3}He,d)^{10}B REACTIONS IN THE ENERGY RANGE 5.7 TO 10.2 MeV.

S.Hinds and R.Middleton.

Proc. Phys. Soc., Vol. 75, Pt 5, 754-61 (May, 1960).

Angular distributions and excitation functions were measured of ten proton and five deuteron groups arising from the bombardment of Be^{9} with 5.7 to 10.2 MeV He^{3} particles. The proton excitation functions, measured at 10°, are essentially smooth and most of the angular distributions exhibit strong forward peaks which appear to be consistent with a predominantly direct process. All of the deuteron angular distribution and excitation functions are consistent with stripping theory.

539.17

11424 AN INVESTIGATION OF THE (^{3}He,p), (^{3}He,d) AND (^{3}He,α) REACTIONS WITH ^{12}C AT BOMBARDING ENERGIES BETWEEN 6 AND 10 MeV.

S.Hinds and R.Middleton.

Proc. Phys. Soc., Vol. 75, Pt 5, 745-53 (May, 1960).

Angular distributions were measured of some proton, deuteron and α-particle groups arising from the bombardment of C^{12} with 5.98, 8.83, 9.37 and 10.14 MeV He^{3} particles. Excitation functions were measured at a laboratory angle of 10° in the energy interval 5.7 to 10.23 MeV. The results indicate that at most energies the (He^{3},d) and the (He^{3},α) reactions proceed predominantly by a direct process, but this is not true for the (He^{3},p) reaction.

539.17

11425 HE-ION INDUCED REACTIONS OF ALUMINUM AND MAGNESIUM.

R.H.Lindsay and R.J.Carr.

Phys. Rev., Vol. 118, No. 5, 1293-7 (June 1, 1960).

The Al^{27}(α,3p)Mg^{28} and Mg^{26}(α,2p)Mg^{28} reactions produced by the bombardment of aluminium and magnesium targets with 42-MeV He ions were studied. The excitation functions for these reactions are presented. At 40-MeV He-ion bombarding energy, the cross-section for the (α,3p) is about 80 microbarns and the peak yield of the (α,2p) reaction observed at 34 MeV is 1.65 mb. Excitation functions are also given for the production of Na^{22} from the bombardment of aluminium with 30-42 MeV He ions, which proceeds chiefly through the reaction Al^{27}(α,2αn)Na^{22}, and of Na^{24} from the bombardment of natural magnesium, primarily through the Mg^{25}(α,αp)Na^{24} reaction.

539.17

11426 Li^{7}(α,p)Be^{10} AND Li^{6}(α,p)Be^{9} REACTIONS AT 30 MeV.

P.R.Klein, N.Cindro, L.W.Swenson and N.S.Wall.

Nuclear Phys., Vol. 16, No. 2, 374-6 (May (1), 1960).

Angular distributions for the Li^{7}(α,p)Be^{10} and Li^{6}(α,p)Be^{9} reactions were obtained for the ground state of the residual nucleus, using 30 MeV α-particles. In the case of the Li^{7} reaction an angular distribution was obtained leaving the residual nucleus in the first excited state. Of particular interest in all three of these angular distributions is the sharp increase in differential cross-section at back angles. It is shown that the present theories of direct reactions are inadequate to account for this structure.

539.17

11427 NITROGEN—ALUMINIUM ELASTIC SCATTERING.

M.L.Halbert and A.Zucker.

Nuclear Phys., Vol. 16, No. 1, 158-67 (April, 1960).

The differential cross-section for elastic scattering of 27.3 MeV nitrogen ions from aluminium was measured from 36^0 to 134^0 in the centre-of-mass system. A coincidence system detecting both the nitrogen and the aluminium ions was used to identify the elastic events. The angular resolution was about $\pm 1^0$. The ratio of the elastic cross-section to the Coulomb cross-section exhibits a small rise above unity near 50^0 (c.m.), then drops almost exponentially from 60^0 to 134^0 (c.m.), where it has a value of 0.0265. The results of the experiment are compared with the predictions of a sharp cutoff calculation. Reasonably good agreement is obtained from 36^0 to 96^0 (c.m.) with an interaction radius $R = 9.07 \times 10^{-13}$ cm. Defining $R = r_0(A_1^{1/3} + A_2^{1/3})$, the value of r_0 is 1.68×10^{-13} cm. Beyond 96^0 (c.m.) the sharp cutoff calculation displays increasing oscillations and no longer fits the data. The resultsof a semi-classical scattering theory due to Ford and Wheeler (Abstr. 10607 of 1959) are also compared with the experimental data. The best fit is obtained for a rainbow angle $\theta_r = 94^0$, corresponding to $r_0 = 1.59 \times 10^{-13}$ cm, and a surface thickness parameter $\Delta R = 0.83 \times 10^{-13}$ cm. Quite good agreement between this theory and experiment is obtained from about 94^0 to 134^0 (c.m.).

539.17

11428 COULOMB EXCITATION OF Li^7, F^{19} AND Na^{23} BY Ne^{20} IONS.

P.H.Stelson and F.K.McGowan.

Nuclear Phys., Vol. 116, No. 1, 92-8 (April, 1960).

Ne^{20} ions of 9 to 11 MeV obtained by the acceleration of doubly-charged ions in the ORNL 5.5 MV Van de Graaff were used to study Coulomb excitation in light nuclei. Excitation of the following states was observed: Li^7, 478 keV; F^{19}, 110 and 197 keV; Na^{23}, 440 keV. Absolute values for the reduced electromagnetic transition rates were obtained with an accuracy of ±20%.

539.17

11429 CROSS-SECTION FOR PRODUCTION OF Cm^{240} BY IRRADIATION OF Th^{232} WITH C^{12} AND C^{13} IONS.

L.I.Guseva, B.F.Myasoedov, N.I.Tarantin and K.V.Filippova.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 973-7 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 694-6 (April, 1960).

Dependence of the cross-sections of the reactions $Th^{232}(C^{12}, 4n)Cm^{240}$ and $Th^{232}(C^{13}, 5n)Cm^{240}$ on the energy of the bombarding particles was determined by irradiating a stack of thin foils and subsequently analysing the reaction products. The curves of the reaction cross-sections have distinct peaks characteristic of the evaporation of neutrons from an excited compound nucleus. The peak values of the cross-sections for the reactions $Th^{232}(C^{12}, 4n)Cm^{240}$ and $Th^{232}(C^{13}, 5n)Cm^{240}$ are respectively 8×10^{-29} cm^2 and 1.8×10^{-29} cm^2. Comparison of the reaction cross-sections obtained by bombarding thorium with the cross-sections of other nuclear reactions shows that the cross-section for reactions involving evaporation of neutrons does not depend on Z^2/A in a simple manner.

539.17 : 539.16

PRODUCTION OF Mo^{93m} IN THE REACTION $Se^{80}(O^{16},3n$

See Abstr. 11335

539.17 : 523.877

11430 NEON AND OXYGEN THERMONUCLEAR REACTIONS.

A.G.W.Cameron.

Astrophys. J., Vol. 130, No. 3, 895-915 (Nov., 1959).

Following the consumption of helium and carbon in a star, O^{16} and Ne^{20} will be among the principal products formed. If the temperature rises to about 1.3×10^9 ^{0}K, both these nuclei will be destroyed. The following reactions take place, producing light particles: $Ne^{20}(\gamma, \alpha)O^{16}$, $O^{16}(O^{16}, n)S^{31}(\beta^+ \nu)P^{31}$, $O^{16}(O^{16}, p)P^{31}$, $O^{16}(O^{16}, 2p)Si^{30}$, and $O^{16}(O^{16}, \alpha)Si^{28}$. Branching ratios have been estimated for these reactions. The particles react with a large variety of medium-weight and heavy nuclei; cross-sections for these interactions have been estimated, including modifications introduced by photobeta and photoneutron reactions. The latter greatly decrease effective neutron-capture cross-sections when neutron binding energies are small. The abundance differential equations have been integrated with a variety of assumptions about the initial abundances. In all cases it was found that the principal products were Mg^{24}, Si^{28}, and S^{32}, with negligible formation of heavy-element overabundances.

539.17

11431 THE FINE STRUCTURE OF THE GIANT RESONANCE.

N.A.Burgov, G.V.Danil'yan, B.S.Dolbilkin, L.E.Lazareva and F.A.Nikolaev.

Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1811-14 (Dec., 1959). In Russian.

The total absorption of γ-rays in carbon was investigated, using a pair spectrometer. In the analysis of the transmitted radiation the resolution was about 100 keV. The absorption cross-section exhibits four peaks in the energy region 22-23.5 MeV. J.A.Evans

539.17

11432 PHOTOPROTONS FROM MEDIUM AND HEAVY ELEMENTS.

W.C.Barber and V.J.Vanhuyse.

Nuclear Phys., Vol. 16, No. 3, 381-401 (May (2), 1960).

Energy and angular distributions of protons produced by electron bombardment of targets of Nb, In, Ta, and Au were measured. Yield curves as a function of electron energy up to 40 MeV were measured for Nb, In, and Ta. The angular distributions are strongly forward for Ta and Au, less so for Nb, and slightly backward for In. The energy distributions are fairly smooth functions except in the case of Ta where two peaks are observed at about 9.5 and 11.5 MeV. The yields were analysed by means of a calculated number of photons (real and virtual) accompanying the electron through the target, and the following photoproton cross-sections integrated over photon energy were obtained: Nb, 230 MeV mb; In, 90 MeV mb; Ta, 60 MeV mb; and Au, 75 MeV mb; the results have an estimated accuracy of ±25%.

539.17

11433 TOTAL GAMMA ABSORPTION IN C^{12}, N^{14}, O^{16}, AND Al^{27} AT 20 MeV.

E.E.Carroll, Jr and W.E.Stephens.

Phys. Rev., Vol. 118, No. 5, 1256-60 (June 1, 1960).

Total gamma absorption cross-sections were measured of C^{12} from 20.0 to 21.2 MeV, and of N^{14}, O^{16}, and Al^{27} from 20.0 to 20.5 MeV using monochromatic gamma rays. A direct absorption technique was used, utilizing $T^3(p,\gamma)He^4$ photons, varied in energy by changing the energy of the incident protons. The C^{12} cross-section showed structure with possible resonances at 20.15, 20.46, and 20.92 MeV with integrated cross-sections of 1.1, 1.0, and 6.6 MeV millibarns, respectively. O^{16} showed a sharply rising cross-section suggesting a strong resonance above about 20.3 MeV. The cross-sections of N^{14} and Al^{27} were smooth over the energy interval investigated.

539.17

11434 YIELD CURVES OF PHOTOPROTONS FROM THE NUCLEUS C^{12}.

E.B.Bazhanov.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 267-9 (Jan., 1960). In Russian.

Photoprotons from a carbon target 150 mg/cm^2 thick were observed at 57.5^0 to a beam of bremsstrahlung γ-rays, using a scintillation telescope. Results are given for three ranges of proton energies with means of 21.4, 27.0 and 34.3 MeV. Gross yield cross-sections at each energy are plotted as a function of maximum γ-ray energy from 35 to 90 MeV and reduced values are compared with those calculated by Dedrick (Abstr. 664 of 1956). J.H.Fremlin

539.17

11435 ENERGY SPECTRA AND ANGULAR DISTRIBUTION OF PHOTONEUTRONS FROM CARBON.

V.Emma, C.Milone and A.Rubbino.

Phys. Rev., Vol. 118, No. 5, 1297-1301 (June 1, 1960).

The energy spectra and angular distribution of photoneutrons from carbon were studied by irradiation with a 30 MeV bremsstrahlung beam. The spectra exhibit a fine structure from which the following levels in C^{12} may be distinguished: 21.4, 22.2, 22.9, 23.6, (24.3), 24.8, and 25.6 MeV. Many of these coincide with levels found in the $C^{12}(\gamma,p)$ and $C^{12}(\gamma,3\alpha)$ reactions. Photoneutron emission occurs predominantly by transition to the ground state of C^{11}. The angular distribution is of the form $(1 + 1.5 \sin^2\theta)$ for all neutrons having energy $E_n > 3$ MeV. This distribution agrees with that expected according to Wilkinson's independent-particle model for ejection from the $l = 1$ orbit.

539.17 : 539.14

PHOTONEUTRON THRESHOLDS FOR 73 NUCLIDES.

See Abstr. 11296

539.17

11436 LOW-ANGLE RAYLEIGH SCATTERING OF Co^{60} γ-RAYS.

S.A.Belskii and S.V.Starodubtsev.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 983-90 (Oct., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 700-4 (April, 1960).

The integral cross-sections for Rayleigh scattering of γ-rays from Co^{60} into angles between 15' and 1°00' and between 15' and 2°30' were measured for U, Pb, W, Ta, Sn, Cu and Ni. The quadratic dependence of the Rayleigh scattering cross-section on the atomic number of the scatterer predicted by the Debye—Franz theory in the low-angle region is confirmed. It is shown that the experimental Rayleigh scattering cross-section exceeds the theoretical cross-section values and that with decrease of Z the angular dependence of the scattering cross-section becomes more pronounced than that predicted by the theory.

539.17

11437 THE PHOTONUCLEAR REACTIONS (γ,d) AND (γ,np) ON K^{39}.

P.Horvat, J.Pahor and M.Vakselj.
Nuclear Phys., Vol. 16, No. 1, 90-1 (April, 1960).

A^{37} was identified as the product of (γ,d) and (γ,np) reactions on K^{39}. The combined yield curve of these reactions was measured for X-rays of 20 to 25 MeV maximum energy. A proportional counter technique for gaseous sources was used for spectrum identification and for yield curve measurements.

539.17

11438 THE PHOTODISINTEGRATION OF NITROGEN.

D.Balfour and D.C.Menzies.
Proc. Phys. Soc., Vol. 75, Pt 4, 543-56 (April 1, 1960).

The (γ,p), (γ,n), (γ,pn) reactions in nitrogen are studied. A cloud chamber, operating at a pressure of about 40 cm of mercury, was exposed to a bremsstrahlung beam from the 340 MeV Glasgow synchrotron, and the energy and angular distributions of the recoil nuclei from the reactions N^{14}(γ,p)C^{13}, N^{14}(γ,n)N^{13}, and N^{14}(γ,pn)C^{12} were measured. The results are compared with the distributions to be expected from several nuclear models, and it is concluded that Wilkinson's model (1956) describes the (γ,p) and (γ,n) reactions satisfactorily, while the (γ,pn) reaction appears to proceed either by a statistical or a knock-on process. No evidence is found to suggest that many of the observed (γ,pn) events could be explained by Levinger's quasi-deuteron model (1951).

539.17

11439 MULTIPLICITY OF RESONANCE NEUTRON CAPTURE GAMMA RAYS.

J.E.Draper and T.E.Springer.
Nuclear Phys., Vol. 16, No. 1, 27-37 (April, 1960).

Measurements of the multiplicity (the average number) of resonance neutron-capture gamma-rays are reported for 23 resonances of 15 nuclides in the range A = 110 to 198 by comparison with the known multiplicity for B^{10}(n,γ). Multiplicities of two resonances forming Eu^{152}, two resonances forming Er^{168}, three resonances forming Lu^{177} and two resonances forming Hf^{178} were not dependent on resonance energy within the limits of experimental uncertainty. Significant variations were found among the multiplicities of three resonances forming In^{116} and two resonances forming Sm^{150}. There is some evidence that J = 3 for the 3.9 eV resonance forming Ho^{166}. Direct measurements of the resonance J values are not yet available for comparison.

539.17

11440 NEUTRON TOTAL CROSS-SECTIONS IN THE 12 TO 21 MeV REGION.

G.J.McCallum, G.S.Mani and A.T.G.Ferguson.
Nuclear Phys., Vol. 16, No. 2, 313-17 (May (1), 1960).

Measurements were made of the neutron total cross-sections of a number of elements at neutron energies between 12 and 21 MeV. The results are discussed in terms of a simple optical model.

539.17

11441 RADIATIVE CAPTURE OF NEUTRONS.

D.F.Zaretskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1084-7 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 772-4 (April, 1960).

An expression for the partial width of the radiative capture of neutrons in states described by shell-model wave-functions is derive It is shown that in the case of s-neutrons this width is proportional to the reduced neutron width for these neutrons. The relative probabilities for transitions to the 2p$_{1/2}$ and 2p$_{3/2}$ shell-model states are calculated for a number of nuclei. The intensity ratios thus obtained are in good agreement with experiment.

539.17 : 539.12

11442 SPECTRA OF SECONDARY NEUTRONS PRODUCED IN THE PASSAGE OF FAST NEUTRONS THROUGH LAYERS OF VARIOUS MATERIALS.

Yu.S.Zamyatnin, E.K.Gutnikova, N.I.Ivanova and I.N.Safina.
J. Nuclear Energy, Vol. 9, No. 1-4, 41-2 (June, 1959). English translation from: Atomnaya Energiya, Vol. 3, 540 (1957).

The energy spectrum of secondary neutrons resulting from 14 MeV neutron bombardment was measured for a number of elements covering a wide range of mass number A. A spherical layer of the element was placed round a DT neutron source and the neutron spectra obtained by measuring the range of forward-scattered protons in nuclear emulsions. The results were compared with statistical theory and values of the nuclear temperature T obtained for each element. It was found that the statistical model does not apply to the lightest nuclei studied which had A ~ 5-10. Between A = 25 and A = 200, T diminishes with increasing A, to about half its original value. Bi and Pb have exceptionally large T since they contain closed shell nuclei with unusually wide level spacing.

R.E.Meads

539.17

11443 THEORY OF DIRECT INTERACTION IN NUCLEON INELASTIC SCATTERING.

S.Yoshida.
Progr. theor. Phys., Vol. 19, No. 2, 169-91 (Feb., 1958).

For the inelastic scattering of nucleons at low and intermediate energies an approximate method is proposed by which the direct interaction process is calculated. From the coupled equation for the radial wave-functions in various channels a standing-wave solutio is obtained by perturbation approximation. For the asymptotic form of the wave-function in the outgoing channel a proper form is chosen in such a way that the higher order contributions in perturbation expansion become small. The generalized K-matrix is calculated from the first-order solution and later the S-matrix is transformed from the K-matrix. This method can give the exact solution in some simple cases and also is expected to give a good approximation in general cases. By assuming a simple zero-range force between a nucleon in the nucleus and the incident neutron, the approximate method is applied to the inelastic scattering of neutrons by Mg^{24} The effect of the Pauli principle is also estimated. The same proces is calculated by assuming the collective excitation and both results are compared.

539.17

11444 SINGLE PARTICLE TRANSITION IN NEUTRON INELASTIC SCATTERING BY DEFORMED NUCLEI.

H.Matsunobu and S.Yoshida.
Progr. theor. Phys., Vol. 19, No. 6, 599-606 (June, 1958).

The contribution from the direct interaction process to the nucleon inelastic scattering changing the intrinsic configuration of th deformed nucleus is investigated. The perturbation calculations, wit the zero-range two-body force, is carried out using waves distorted by the collective surface interaction. The resulting cross-section is small compared with the cross-section for the usual rotational excitation and justified the approximation contained in the latter calculation. See also preceding abstract.

539.17 : 539.14

EFFECTS OF A NUCLEAR OCTUPOLE MOMENT ON NEUTRON SCATTERING.

See Abstr. 11305

539.17

11445 INELASTIC NEUTRON SCATTERING CROSS SECTIONS FOR SOME LIGHT NUCLEI AT 14 MeV.

V.M.Gorbachev and L.B.Poretskii.
J. nuclear Energy, Vol. 9, No. 1-4, 159-60 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 191 (1958).

Describes measurements of the inelastic cross-section of Li^{6}, Li^{7}, Be^{9}, B and C for 14 MeV neutrons. Neutron transmission through targets was measured by counting recoil protons using a telescope consisting of three proportional counters and an anthracene-activated napthalene scintillation counter with its energy discrimination level set to 7 MeV.

R.H.Thoma

539.17

11446 EXPERIMENTS INVOLVING THE EMISSION OF PARTICLES FROM COMPOUND NUCLEI.

R.S.Storey, W.Jack and A.Ward.
Proc. Phys. Soc., Vol. 75, Pt 4, 526-38 (April 1, 1960).

A scintillation-counter technique is described which allows rapid measurements of energy spectra and cross-sections in (n, p) reactions, integrated over essentially 4π-geometry. At a neutron energy of 14.1 MeV, measurements were made on Al^{27}, Fe^{54}, Fe^{56}, Ni^{58}, Co^{59}, Ni^{60}, Cu^{63}, Zn^{64} and Cu^{65}, and at 13.0 and 15.7 MeV on Fe^{54}, Ni^{58} and Zn^{64}. When corrected for barrier transmission the measured energy spectra have a Maxwellian form $\exp(-E/T_m)$ and, excluding Al^{27} and Cu^{65}, the average value of $E_C{}^*/AT_m{}^2$ is constant within the experimental error of 3% in T_m, and equals $0.158 \pm 0.003\ MeV^{-1}$ ($E_C{}^*$ is the excitation energy and A is the atomic mass number of the compound nucleus). The values of the integrated cross-sections σ(n, p) are in reasonable agreement with the relation $\sigma(n, p) \propto \exp[-(E_b + P)/T_m]$, where E_b is the binding energy and P is related to the pairing energy in the compound nucleus. Measured values of T_m and σ(n, p) are tabulated. Some results of others are used to obtain values of T_m and integrated cross-sections, and these are not inconsistent with the results of the experiments described here.

539.17

11447 THE THERMAL NEUTRON CAPTURE CROSS SECTION AND RESONANCE CAPTURE INTEGRAL OF PROTACTINIUM-233. T.A.Eastwood and R.D.Werner.

Canad. J. Phys., Vol.38, No. 6, 751-69 (June, 1960).

The thermal neutron capture cross-section and resonance capture integral of Pa^{233} to form the 1.2 min and 6.7 hr isomeric states of Pa^{234} were measured using activation methods. The results are as follows:

	$Pa^{233}(n,\gamma)Pa^{234}$ (1.2 min)	$Pa^{233}(n,\gamma)Pa^{234}$ (6.7 hr)
Thermal neutron capture cross-sections, barns	20 ± 4	19 ± 3
Resonance integral, including 1/v part, 0.5 eV to ∞, barns	470 ± 90	460 ± 100
s_0	27 ± 5	27 ± 5
Effective cross-section in NRX lattice position, ($r\sqrt{T/T_0} = 0.023$), barns	32 ± 5	31 ± 5
Total effective cross-section in NRX lattice position, barns	63 ± 7	

Irradiations made with different thicknesses of cadmium cover show the absence of a major resonance for the formation of the 6.7 hr state in the region of the cadmium cutoff. The results are compared with earlier values and some reasons for discrepancies were studied experimentally.

539.17

11448 MEASUREMENT OF GAMMA AND X-RAY CAPTURE SPECTRA OF Sm AND Gd. J.T.Wasson.

Z. Naturforsch., Vol. 15a, No. 3, 276 (March, 1960). In German.

An accurate determination of the energies within the range of 20 to 450 keV of gamma-rays and X-rays from the neutron capture in Sm and Gd is described. S.J.St-Lorant

539.17

11449 ON THE EXPERIMENTAL POSSIBILITY OF TESTING THE FORM FACTORS IN THE THEORY OF THE UNIVERSAL FERMI INTERACTION. Khè Tszo-Syu.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 648-50 (Feb., 1960). In Russian.

The probability of muon capture by a nucleus of spin $\frac{1}{2}$ without the emission of neutrons and protons is calculated, assuming that, after the capture process, the nucleus goes over into a state with spin $\frac{3}{2}$. It turns out that if the muon is captured by the nucleus in the singlet state and if there are no form factors present in the Fermi interaction, then the process is forbidden. The presence of form factors, however, makes the process possible through terms related to the "weak magnetism" and the "effective pseudoscalar interaction". The probability is about $\frac{1}{8}$ of an ordinary transition. The experimental possibilities of observing such a transition are discussed. P.Roman

539.17 : 539.16

MILLISECOND HALF-LIFE ISOMERS PRODUCED IN REACTIONS INVOLVING 14 MeV NEUTRONS. See Abstr. 11376

539.17

11450 CROSS-SECTIONS FOR ELASTIC SCATTERING OF 195 MeV POSITIVE PIONS BY CARBON AND LITHIUM NUCLEI.

V.G.Ivanov, V.T.Osipenkov, N.I.Petrov and V.A.Rusakov.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 863-6 (Sept., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 615-16 (March, 1960).

The carbon ($1.72\ g\,cm^{-2}$) and lithium ($0.8\ g\,cm^{-2}$) targets were placed in a cloud chamber with a magnetic field of 13 500 oersted. In the interval 10°-180° 410 elastic scattering events were observed from carbon and 243 from lithium, giving total elastic cross-sections of 204 ± 26 and 156 ± 26 millibarns. The angular distributions are compared with the results of crude optical-model calculations. A.Ashmore

539.17

11451 INELASTIC SCATTERING AND ABSORPTION OF 195 ± 15 MeV π^+-MESONS BY CARBON AND LITHIUM NUCLEI. N.I.Petrov, V.G.Ivanov and V.A.Rusakov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 957-65 (Oct., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 682-8 (April, 1960).

Inelastic scattering and absorption of (195 ± 15) MeV π^+-mesons by carbon and lithium nuclei were studied with a cloud chamber in a magnetic field. The total and differential inelastic scattering cross-sections and also the total cross-section for exchange scattering and absorption of π^+-mesons were determined. The experimental data obtained are compared with the results of calculation of a cascade in the carbon nucleus and it is shown that inelastic scattering of mesons can be satisfactorily described on the basis of the pair collision hypothesis. It is shown that only two nucleons of the nucleus participate actively in the act of absorption of a (195 ± 15) MeV π^+-meson. The probability of meson capture by n—p pairs is 2-3 times larger in this case than the probability of capture by pairs of identical nucleons.

539.17

11452 INELASTIC INTERACTIONS BETWEEN 80-300 MeV π^+-MESONS AND LIGHT NUCLEI.

A.G.Meshkovskii and Ya.Ya.Shalamov.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 978-82 (Oct., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 697-9 (April, 1960).

The cross-sections for inelastic interaction (absorption and scattering) between π^+-mesons and a mixture of C, F and Cl nuclei were measured for ten values of the π^+-meson energy in the region from 80 to 300 MeV. The results are compared with curves calculated on the basis of the optical model assuming alternately a uniform distribution of the nuclear charge and a Fermi type distribution. It is shown that the experimental results satisfy the Fermi type distribution. The cross-sections for inelastic scattering of π^+-mesons were also measured.

539.17 : 539.2

THE ROLE OF VACANCIES AND DISLOCATIONS IN THE NUCLEATION AND GROWTH OF GAS BUBBLES IN IRRADIATED FISSILE MATERIAL. See Abstr. 9903

539.17

11453 ANALYSIS OF THE TWO-MODE-OF-FISSION HYPOTHESIS. G.P.Ford.

Phys. Rev., Vol. 118, No. 5, 1261-70 (June 1, 1960).

Mass yields for gamma fission of U^{238}, proton fission of Th^{232}, alpha fission of U^{238}, and deuteron fission of normal uranium have been examined in terms of vector spaces for consistency with the hypothesis that for each target and projectile there are two and only two modes of fission. The first three cases are on the whole consistent with the hypothesis. The fourth is not consistent with the hypothesis; the measured yields include some yields from neutron fission. Some consequences of the hypothesis with the added requirement of non-negative yields and non-negative coordinates are derived.

539.17

11454 ANGULAR ANISOTROPY AND ENERGY CHARACTERISTICS OF THE FISSION PROCESS.

A.N.Protopopov, I.A.Baranov and V.P.Eismont.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1608-9 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1143 (Nov., 1959).

It is expected that there will be an anisotropy in the energy yield from the fission of heavy nuclei. This effect was studied by bombarding U^{238} with neutrons of energy 14.9 MeV. The energy of the fission fragments along and perpendicular to the direction of the neutron beam was determined. It was found that, for a ratio of the fragment masses of 1.4 to 1.44, the difference in the energy of fragments between the two angles is not bigger than 1.5%.

S.E.Hunt

539.17

11455 YIELDS OF SOME HEAVY FRAGMENTS IN THE FISSION OF U^{233}.

R.N.Ivanov, V.K.Forshkov, M.P.Anikina, G.M.Kukavadze and B.V.Ershler.

J. nuclear Energy, Vol. 9, No. 1-4, 46-9 (June, 1959). English translation from: Atomnaya Energiya, Vol. 3, 546 (1957).

The absolute yields of some rare-earth fission products from U^{233} were found by mass-spectrometer analysis. Results by two methods, with and without chemical separation, were in agreement. From the yields it was also possible to calculate the thermal-neutron absorption cross-sections of Sm^{149} and Xe^{135}, in good agreement with the values of others.

S.E.Hunt

539.17 : 539.16

Sr^{90} YIELD FROM ^{233}U FISSION. See Abstr.11363

539.17

11456 THE MEASUREMENT OF ν_{eff} AND $\sigma_f + \sigma_c$ OF ^{235}U AND ^{239}Pu FOR FAST NEUTRONS.

V.N.Andreev.

J. nuclear Energy, Vol. 9, No. 1-4, 151-3 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 185 (1958).

Describes the measurement of $\nu_{eff} = \nu\sigma_f(\sigma_f + \sigma_c)$ and $\sigma_f + \sigma_c$ at neutron energies of 24, 240 and 880 keV for U^{235} and Pu^{239}.

R.H.Thomas

539.17

11457 THE NUMBER OF PROMPT NEUTRONS FROM THE FAST FISSION OF ^{235}U, ^{238}U, ^{232}Th AND ^{237}Np.

B.D.Kuz'minov, L.S.Kutsaeva and I.Bondarenko.

J. nuclear Energy, Vol. 9, No. 1-4, 153-5 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 187 (1959).

Reports measurements of the average number of prompt neutrons produced by the fission of U^{235}, U^{238}, Th^{232} and Np^{237}, using incident neutrons with a fission spectrum

R.H.Thomas

539.17

11458 AVERAGE NUMBER OF PROMPT NEUTRONS FROM THE FISSION OF ^{233}U, ^{235}U AND ^{239}Pu BY 4 AND 15 MeV NEUTRONS.

G.N.Smirenkin, I.I.Bondarenko, L.S.Kutsaeva, Kh.D.Mishchenko, L.I.Prokhorova and B.P.Shemetenko.

J. nuclear Energy, Vol. 9, No. 1-4, 155-7 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 188 (1958).

Reports measurements of the average number of prompt neutrons emitted in the fission of U^{233}, U^{235} and Pu^{239} by 4 and 15 MeV neutrons, using double fission chambers. Within the experimental errors the predicted linear increase of ν with energy was obtained.

R.H.Thomas

539.17

11459 14 MeV FISSION CROSS-SECTIONS OF ^{232}Th AND ^{237}Np.

A.N.Protopopov, Iu.A.Seletskii and S.M.Solov'ev.

J. nuclear Energy, Vol. 9, No. 1-4, 157-9 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 190 (1958).

Reports measurements of the fission cross-section for Th^{232} and Np^{237} for 14 MeV neutrons. The values obtained were: $\sigma = 0.35 \pm 0.02$ barns for Th^{232} and $\sigma \pm 2.4 \pm 0.2$ barns for Np^{237}.

R.H.Thomas

539.17

11460 ON THE ANGULAR DISTRIBUTION OF THE LIGHT AND HEAVY FRAGMENTS FROM THE FISSION OF ^{238} U BY 14 MeV NEUTRONS.

A.N.Protopopov and V.P.Eismont.

J. nuclear Energy, Vol. 9, No. 1-4, 164-5 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 194 (1958).

By using a double screen-grid ionization chamber it was possible to study 856 fission fragment pairs, 424 of which produced a light fragment at 0° to the incident neutron beam and 432 a light fragment at 180°, when a U^{238} sample was bombarded by 14 MeV neutrons. This experiment indicates that fission fragments are emitted symm rically about 90°.

R.H.Thoma

539.1

11461 A DETERMINATION OF ν FOR THE 14.8 MeV NEUTRON-INDUCED FISSION OF ^{235}U.

A.N.Protopopov and M.V.Blinov.

J. nuclear Energy, Vol. 9, No. 1-4, 207-9 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, No. 4 (1958).

The mean number ν, of prompt neutrons emitted in U^{235} fission induced by 14.8 MeV neutrons, was measured relative to that for thermal neutrons. The value obtained is 1.90 ± 0.18, which when taken with a previously determined value for thermal neutrons, gives the value 4.7 ± 0.5 for ν. Fission neutrons were identified by recording their coincidence with fission fragment emission usin a coincidence resolving time of 10^{-7} sec. In order to attain high detection efficiency a double ionization chamber, having two identical U^{235} layers on the high-voltage electrode, was used. Corrections which are applied to the experimental data are discussed.

S.E.Hun

539.1

11462 SEMICONDUCTOR FISSION PROBE.

R.Steinberg.

Nucleonics, Vol. 18, No. 2, 85 (Feb., 1960).

10 series-connected U^{235}-coated p—n junctions were assembled as a neutron detector probe. The probe had a sensitivity of 10^{-3} counts/n.$cm^{-2}$and gave a 75 mV pulse height.

R.D.Smit

539.1

11463 COMPETITION BETWEEN NEUTRON-EVAPORATION PROCESSES AND FISSION IN REACTIONS BETWEEN MULTICHARGED IONS AND HEAVY NUCLEI.

N.I.Tarantin.

Zh. eksper. teor. Fiz., Vol. 38, No. 1, 250-2 (Jan., 1960). In Russian.

Results are given of calculations of Γ_n/Γ_f for compound nucle formed in various heavy-ion reactions with Th^{232}, U^{238} and Pu^{241}. The value of Γ_n/Γ_f decreases rapidly with decrease in atomic weig for given Z, so that fission becomes increasingly probable as neutrons are evaporated. Some comparable results from α-reactions suggest only a small difference from the heavy-ion results and giv little evidence of any specific effects resulting from the use of hea ions.

J.H.Freml

539.

11464 FISSION OF URANIUM U^{238} BY μ^--MESONS.

A.K.Mikhul and M.G.Petrashku.

Rev. de Physique (Bucarest), Vol. 4, No. 3, 355-8 (1959). In Russi

In an emulsion containing 0.055 gm cm^{-3} of U^{238}, 26975 μ^- ending were obtained, of which 59 were fission events giving the probabili (P) of such events as $(2.2 \pm 0.3) \times 10^{-3}$. The probability ($P_1$) of a being captured by an atom was calculated in two ways, one of whic depended on the atomic charge and one which did not. These gave the probability of fission (P_2) as 0.08 ± 0.01 and 1.13 ± 0.14 respe tively (where $P = P_1 P_2$). P_2 was also calculated in two ways: (a) t μ^- being first captured in an optical orbit and then subsequently goi to a lower state causing fission, (b) by means of the reaction $\mu^- + p \rightarrow n + \nu$, P_2 being 0.20 and 0.06 respectively. This indicate that P_1 was dependent on charge.

A.M.Gre

539.

11465 SPONTANEOUS FISSION OF Am^{241}.

V.L.Mikheev, N.K.Skobelev, V.A.Druin and G.N.Flero

Zh. eksper., teor. Fiz., Vol. 37, No. 3(9), 859-61, (Sept., 1959). I Russian. English translation in: Soviet Physics — JETP (New Yo Vol. 37(10), No. 3, 612-13 (March, 1960).

The lower limit for the fission probability of Am^{241} was redetermined using more refined counting techniques and a larger sample than that used previously. An increase of approximately 15 times, on the previous value for the lower limit of the half-life for spontaneous fission being 2×10^{14} years. This figure gives a factor of $\sim 10^5$ times increase on the half-life expected for an eve even nucleus with the same value of Z^2/A which is in approximate agreement with that observed in other nuclei having an odd numbe protons or neutrons.

S.E.H

539

11466 SPONTANEOUS FISSION HALF-LIVES.

T.Sasakawa and M.Yasuno.

Progr. theor. Phys., Vol. 20, No. 3, 315-26 (Sept., 1958).

A dynamical theory of nuclear distortion leading to fission, is resented. This theory is based on the unified (collective) model, ut since spontaneous fission is an irreversible process, the present eory is treated reflecting this speciality. Starting from this ynamical theory, a semi-empirical formula of spontaneous fission alf-lives of even—even nuclei is derived. This formula agrees well ith the general tendency of spontaneous fission half-lives of these uclei. Essential features which affect half-lives are discussed. inally, the asymmetry character of fission and the difference of alf-lives between even—even and even—odd nuclei are discussed.

539.17

11467 STATIONARY FUSION REACTIONS AT LOW TEMPERATURES.

.Nishiyama, T.Sekiya and Y.Watanabe.
rogr. theor. Phys., Vol. 18, No. 1, 93-5 (July, 1957).

The mechanisms responsible for the fusion of H and D μ-mesic toms in liquid hydrogen are discussed. The relation between the nergy output per meson supplied and the relative concentration of and D is calculated as a function of the cross-sections for the eactions involved. The errors involved in the calculations of these ross-sections are such that it is not possible to draw any definite onclusions. E.J.Squires

NUCLEAR POWER STUDIES

539.17

11468 PREDETERMINATION OF THE BEHAVIOUR OF TRANSIENT STATES OF THE 2000 kW REACTOR OF IE BUCAREST INSTITUTE OF ATOMIC PHYSICS.

I.Purica.
ev. de Physique (Bucarest), Vol. 4, No. 3, 283-300 (1959). In French.

A set of approximate equations are given which describe the namic characteristics and thermal behaviour of the reactor and cooling circuits. The coefficients of these equations are discussed particular their variation with temperature), and the experimental ethods used to determine them and the transfer function of the stem, are described. With this information the behaviour of the actor can be predicted when sudden changes are made in the activity. Knowledge of the transfer function also enables instability nes to be determined. D.H.Lord

539.17 : 621.311.25

11469 DUAL CYCLE BOILING WATER REACTORS.

Yu.D.Arsenyev.
nuclear Energy, Vol. 9, No. 1-4, 201-5 (June, 1959). English anslation from: Atomnaya Energiya, Vol. 4, 367 (1958).

Two dual-cycle systems are compared, namely those in which e turbines are fed with steam from the reactor and either with eam of intermediate pressure directly or indirectly generated from essurized-water heated in the reactor. The example taken is a iling-water reactor with an electrical output of about 180 MW. rves are given relating the pressure in the evaporator and loading efficient of the reactor for various multiplicities of circulation in e reactor and various temperatures of regeneration. J.F.Hill

539.17

11470 CALCULATION METHODS FOR THE CRITICAL SIZE OF A D_2O MODERATED, WET STEAM COOLED EACTOR. I. CLUSTER FREE ELEMENT. II. CONCENTRIC NNULI FUEL ELEMENT.

Bonalumi, S.Bruschetti and G.B.Zorzoli.
ergia nucleare, Vol. 7, No. 3, 192-209 (March); No. 4, 270-86 pril, 1960).

The calculations are performed for a cylindrical reactor with an ter graphite reflector on the sides and heavy water reflector on e ends in addition to an inner heavy water reflector placed mmetrically along the axis. The first part deals with fuel elements nsisting of clusters of seven hollow rods of 98% by weight of tural uranium and 2% by weight of zirconium. Each rod is clad in rcaloy-2 and surrounded by a Zircaloy tube to guide the coolant. e cluster of rods is surrounded by a zirconium pressure tube which turn is surrounded by an aluminium tube with an air gap in between e two. In order to perform the lattice calculation each cluster is omogenized", that is, separated into cylindrical regions of the ferent materials. Values of ϵ, p, f and the multiplication constant e then calculated for a square lattice. In the case of ϵ the interaction fast effect is taken into account and for p a two-group calculation is used. In addition values of the slowing down and diffusion lengths are found leading to the buckling using a one-group theory and the critical size for different lattice pitches. The calculations of critical size are checked for different lattice pitches. The calculation of critical size are checked for one case using a two-group theory and good agreement is found. In the second part the fuel element consists essentially of two concentric rings of fuel with attendant tubes and coolant. More refined calculations than those normally used for calculating the lattice constants are employed, and again the critical size is found as a function of the lattice pitch. In a particular case the thermal and epithermal flux is calculated as a function of distance from the reactor axis. J.F.Hill

539.17

11471 A MONTECARLO CALCULATION OF THE N^{16} PRODUCTION IN A LATINA TYPE REACTOR.

E.Diana, A.Kind and V.Pierpaoli.
Energia nucleare, Vol. 7, No. 5, 342-9 (May, 1960).

The Monte Carlo method is applied to the calculation of the radioactive N^{16} production taking place in the cooling channels of a heterogeneous natural uranium graphite reactor due to fast neutron irradiation of CO_2. The rate of N^{16} production is given as a function of reactor power.

539.17

11472 REACTOR FUEL ELEMENTS.

J.F.Schumar.
Sci. American, Vol. 200, No. 2, 37-43 (Feb., 1959).

A review of the difficulties connected with corrosion and distortion of reactor fuel elements due to the formation of fission products, and the various methods of overcoming or circumventing them by alloying, methods of jacketing or use of ceramic fuels.

539.17

11473 DELAYED NEUTRON DETECTION METHODS APPLIED TO THE DETECTION AND LOCATION OF REACTOR FUEL ELEMENT FAILURES.

R.A.Dewes and J.C.Childs.
Trans Amer. Inst. Elect. Engrs I, Vol. 78, 1065-9 (1960) = Commun. and Electronics, No. 46 (Jan., 1960).

The method consists of measuring the neutron activity of a flowing sample of primary coolant fluid as it passes through a delayed neutron detection station. The presence of neutron activity above a certain predetermined background level indicates the presence of fission product emitting surfaces in the reactor system. The activity arises from the fission product I^{137} and Br^{87}, which are delayed neutron emitters, entering the coolant stream by recoil from an exposed fuel surface. In order to locate the failure within a multicellular reactor core, either of two methods may be employed. The first of these involves auxiliary equipment which permits continuous flow of primary coolant samples from selected portions of the reactor core through individual sampling lines. A measurement of the neutron activity of the effluent from each of these lines indicates the location of the failure within the resolution of the sample line intake location. A second, less complicated, method has been found to be usable in this application and may be applicable to most reactors. This method, termed the "flux" depression method, utilizes the local reduction in flux which accompanies the insertion of one or more control rods at constant average reactor power. Such a rod manipulation depresses the specific fissioning rate in the region of the inserted rod(s), with the spatial extent and amount of flux depression depending upon many parameters. If a failure is present in the region of the depressed flux zone, the average neutron activity of the primary coolant as measured by the permanently installed delayed neutron detecting station is found to decrease. The failure is thus located within the resolution of the flux depression pattern of various rod movements. The failure detection equipment is described in detail and the auxiliary equipment for locating the faulty element is outlined. Determinations of fission product activity obtained with the detector in a pressurised water reactor are compared with results obtained by radiochemical analyses of the coolant, these agree within a factor of two. A.J.Salmon

539.17 : 621.311.25

11474 A PROCEDURE FOR SAFELY STARTING UP A REACTOR.

B.G.Dubovskii.
J. nuclear Energy, Vol. 9, No. 1-4, 200-1 (June, 1959). In Russian. English translation from: Atomnaya Energiya, Vol. 4, 365 (1958).

To ensure that when starting-up a reactor emerges into the measureable range of power levels at an acceptable rate of power increase, it is suggested that an Sb + Be source is inserted in the reactor. This creates a sufficient photo-neutron source to reduce the unrecorded range of powers to an acceptable value. A table is given of the subsequent power increase and doubling time for a particular reactor consequent upont the steady removal of the control rods. J.F.Hill

539.17

11475 LOSS OF CHARGED PARTICLES IN A STELLARATOR DURING OHMIC HEATING.
R.A.Ellis, L.P.Goldberg and J.G.Gorman.
Phys. of Fluids, Vol. 3, No. 3, 468-73 (May-June, 1960).

The average charged particle confinement times τ_0 in hydrogen and deuterium plasmas during ohmic heating in the B-3 stellarator were determined. The observed values of τ_0 are approximately proportional to the square root of the magnetic confining field and were less than the values expected on the basis of classical collisional diffusion. The low values of τ_0 persisted when the system was, in theory, made hydromagnetically stable by the addition of helical stabilizing winding. It is inferred that the observed low confinement times are not due to a known hydromagnetic instability.

539.17

11476 AN EVALUATION OF THE DEUTERON VELOCITY SPECTRUM IN SCEPTRE III. S.E.Hunt.
Proc. Phys. Soc., Vol. 75, Pt 4, 596-606 (April 1, 1960).

The mean energies of protons observed at 45° and 135° to the direction of positive gas current flow in the toroidal pinched discharge apparatus Sceptre III and the energy spread of these protons indicate that they originate from fusing deuterons $[D(d,p)H^3]$ having a range of centre-of-mass velocities in the ϕ direction. The experimental results can be explained in terms of a fast tail of deuterons with velocities between 4×10^7 cm sec^{-1} and 16×10^7 cm sec^{-1} fusing with a much larger number of deuterons travelling at lower velocities. The proton yield indicates that the deuteron population falls off roughly exponentially with increasing velocity, about 1 in 10^3 of the total deuterons present having velocities of between 4 and 16×10^7 cm sec^{-1}. Such a distribution is consistent with a very high proportion of the deuterons present having velocities of less than 10^7 cm sec^{-1} in the ϕ direction, as is indicated by spectroscopic measurements. The proton-energy measurements also indicate that the deuterons are moving in the θ sense and the effect of this motion is also considered.

ATOMS

539.18

11477 ATOMIC RADII OF THE ELEMENTS. ELEMENTS CHARACTERIZED BY THEIR s AND p ELECTRONS OF THE OUTER SHELLS 1, 2, 3 AND 4. R.Aynard.
C. R. Acad. Sci. (Paris), Vol. 250, No. 15, 2683-5 (April 11, 1960). In French.

The free-atom radii for these elements can be plotted on Morse curves, the abscissae being the numbers of s and p electrons in filled shells, and the parameters being the same for all elements in a given group. See also Abstr. 10147 of 1959 and following abstracts. J.Hawgood

539.18

11478 ATOMIC RADII OF THE ELEMENTS. ELEMENTS CHARACTERIZED BY THEIR d AND f ELECTRONS OF THE INNER SHELLS (3 TO 7). R.Aynard.
C. R. Acad. Sci. (Paris), Vol. 250, No. 16, 2804-6 (April 20, 1960). In French.

See preceding abstract. For these transition elements, the free-atom radii can be plotted on parabolae. J.Hawgood

539.18

11479 ATOMIC NUMBERS OF THE ELEMENTS. R.Aynard.
C. R. Acad. Sci. (Paris), Vol. 250, No. 17, 2848-9 (April 25, 1960). In French.

See preceding abstracts. Gives a relation between Z and seven numbers characterizing the electronic structure. J.Hawgood

539.18

11480 IMPROVED ATOMIC WAVE FUNCTIONS USING A FUNCTIONAL TRANSFORMATION. G.G.Hall.
Proc.Phys. Soc., Vol. 75, Pt 4, 575-81 (April 1, 1960).

The accuracy of an atomic wave-function is often increased by an adjustment of the overall scale of the wave-function. This method of improving a wave-function is here generalized by considering a variable scale factor which can be an arbitrary function of the radius This type of variation has the valuable property of leaving all the coefficients in the density matrices invariant so that it is much easier to minimize the energy than it is for most parameters. The new integrals which arise are relatively easy to evaluate. To illustrate the power of the method an application is made to the simplest wave-functions for the He isoelectronic sequence. A simple type of variation is found and the results show that a close approximation to the self-consistent-field energies can be obtained from a two-parameter wave-function.

539.18

11481 SIMPLE CONFIGURATION-INTERACTION WAVE FUNCTIONS. I. TWO-ELECTRON IONS: A NUMERICAL STUDY. J.N.Silverman, O.Platas and F.A.Matsen.
J. chem. Phys., Vol. 32, No. 5, 1402-6 (May, 1960).

The ground state energies of the two-electron ions from H^- to Ne^{8+} are calculated for the simple wave-function $(1s1s') + \lambda(2p)^2$ with optimized orbital exponents. The use of the difference between the calculated energy and the experimental energy as a function of the atomic number for accurate extrapolation is explored. The expectation values of the operators $r^n (n \geq -2)$, $\delta^{(3)}(r_1)$, and $\delta^{(3)}(r_{12})$ are compared with those obtained from more accurate wave-functions.

539.18

11482 SIMPLE CONFIGURATION-INTERACTION WAVE FUNCTIONS. II. TWO-ELECTRON IONS: AN ANALYTI STUDY. C.W.Scherr and J.N.Silverman.
J. chem. Phys., Vol. 32, No. 5, 1407-9 (May, 1960).

An analytical study of the ^1S ground state of helium-like ions employing the open-shell function $(1s1s')$ and the angularly correlate configuration-interaction function $(1s1s') + \lambda(2p)^2$ has been made. Expressions for the wave-function parameters, energy values, and certain other expectation values in terms of the nuclear charge Z have been obtained. These are asymptotic expressions for large Z, but they reproduce numerically obtained results for small Z with sufficient accuracy to be useful for many purposes.

539.1

11483 SOME PROPERTIES OF FIRST ORDER DENSITY MATRICES WITH SPECIAL APPLICATION TO MANY-ELECTRON ATOMS. W.A.Bingel.
J. chem. Phys., Vol. 32, No. 5, 1522-30 (May, 1960).

Properties of the first order density matrix $\gamma(x'|x)$ of an N-electron system are discussed, including the relation between $\gamma(x'|x)$ and the spinless first order density matrix $\gamma(r'|r)$ and those symmetry properties of the total electronic charge density $\gamma(r) \equiv \gamma(r|$ which result from the corresponding properties of the total wave function with special reference to many-electron atoms. General formulae are given for the evaluation of $\gamma(r)$ of many-electron atoms in the orbital approximation and for its decomposition into terms of different angular symmetry. These formulae are applied to all terms of the electron configurations $s^n p^m$ and the results collected in tables.

539.1

11484 STUDY OF THE CORRELATIONS BETWEEN THE POSITIONS OF ELECTRONS. S.Odiot.
Cahiers de Phys., Vol. 11, 268-305 (Aug.-Sept., 1957). In French.

The work described is similar to that of Zimmermann and Van Rysselberghe (Abstr. 6352 of 1949) and of Linnett and Poë (Abstr. 3986 of 1952). The author uses the theory of cells introduce by Daudel (Abstr. 1516 of 1954) to correlate the position of electron having parallel spins in atoms. The theory is used to demonstrate that it is possible to associate certain volumes in space with electronic layers and to obtain the average distributions of the electron in space, i.e., a wave-mechanical interpretation is obtained which i similar to that of the electron shell of the old quantum theory. The theory is illustrated by many examples. W.J.Orville-Thoma

539.1

11485 IMPLICATIONS OF PARITY NONCONSERVATION AND TIME REVERSAL NONINVARIANCE IN ELECTROMAGNETIC INTERACTIONS. II. ATOMIC ENERGY LEVELS.

M.Sachs and S.L.Schwebel.
Ann. Phys. (New York), Vol. 8, No. 4, 475-508 (Dec., 1959).

For Pt I, see Abstr. 6513 of 1959. The implications of the parity nonconserving and time reversal noninvariant theory of electromagnetic interactions (developed in Pt I) with regard to the properties of atoms and their associated spectra, are investigated. In the first part of this paper, the modified Dirac equation for the hydrogen atom, in which the extra pseudovector part of the four potential (B_ν) is included, is solved exactly. The solutions are found to depend on a new constant of the motion which replaces the conventional angular momentum operator. This new constant is made up in part of the conventional pseudovector angular momentum (particle) variable and in part of a vector function of the particle and field variables. The results are applied to a determination of new selection rules for magnetic and electric dipole transitions (which are forbidden in the conventional theory) and the calculation of the associated transition probabilities. The contribution of the pseudovector four potential to the measured value of the Lamb shift is calculated. It is found that, analogously to the linear Stark effect in hydrogen, there is a non-Zeeman type linear magnetic field effect in the first excited state of hydrogen. This effect is linear in the mixing parameter ξ. The value of ξ required to account for the present-day discrepancy between the calculated value of the Lamb shift and its measured value, would still insure compatibility with other experimental data. It is also found that the lifetimes of atomic states depend on ξ^2, thus having much less affect on the metastability of the $2S_{1/2}$ state of hydrogen. The second part of this paper deals with the spectra of constituent magnetic ions of paramagnetic crystals. The relationship between the crystalline field interactions with the magnetic ions and time reversal invariance is emphasized. A sample perturbation calculation of the pseudoscalar interaction implied by this theory is then carried out for the case in which a magnetic ion is subjected to a crystalline field (whose symmetry group lacks an inversion centre) and/or an externally applied uniform electric field.

539.18

11486 THE CALCULATION OF THE ENERGY OF He ATOMS.
P.Gombás.
Acta phys. Hungar., Vol. 7, No. 2, 273-5 (1957). In German.

Uses an improvement of the method used by Hylleraas in his fundamental study. W.J.Orville-Thomas

539.18

11487 THE EFFECTIVE EXCITATION CROSS-SECTIONS OF CERTAIN POTASSIUM AND ARGON LINES.
L.M.Volkova.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 23, No. 8, 968-70 (1959). In Russian.

Certain potassium and argon lines were excited using electron beams. The excitation curves (intensity versus incident-electron energy) of the potassium lines at 5359.52, 5782.77 A and the argon line at 8115.31 A are given for electron energies from 0 to 40 eV. The effective excitation cross-section of the potassium line at 4222.98 A ($\sim 10^{-19}$ cm^2) is plotted for 0.60 eV. A.Tybulewicz

539.18

11488 COLLISIONAL DE-EXCITATION OF (π^-,p) ATOMS.
J.E.Russell and G.L.Shaw.
Phys. Rev. Letters, Vol. 4, No. 7, 369-71 (April 1, 1960).

Using the result of $(4 \pm 2) \times 10^{-12}$ sec obtained by Fields et al. [Bulletin of the American Physical Society, No. 4, 402 (1959)], for the time for a π^--meson of velocity 0.05 c to be slowed down and absorbed in a hydrogen bubble chamber, calculations are presented to suggest that this lends support to the conclusion of Day, Snow and Sucher (Abstr. 13732 of 1959) that absorption occurs predominantly from the s-state in (K^-,p) atoms. J.D.Dowell

539.18

11489 AUGER EFFECT IN MESONIC ATOMS.
R.A.Ferrell.
Phys. Rev. Letters, Vol. 4, No. 8, 425-8 (April 15, 1960).

A simple theory of the Auger effect in mesonic atoms is given, which shows that the usual theory is correct, and that the cross-section for the Auger effect is directly related to the photoelectric cross-section. It is suggested that the discrepancy between experimental and theoretical X-ray yields of mesonic atoms is due to experimental errors. D.J.Thouless

539.18

11490 ENERGY LEVELS AND APPROXIMATE WAVE-FUNCTIONS OF MESIC ATOMS. G.E.Pustovalov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1806-17 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1288-95 (Dec., 1959).

A calculation of the energies of the 1S, 2S, 3S, 2P, and 3P levels of mesic atoms is made in the nonrelativistic approximation for a constant distribution of the charge density of the nucleus inside a sphere of radius R_0. Using a numerical solution of the Schrödinger equation, formulae are found for the dependence of the quantum defect Δn on the quantity $t = R_0 Z/a_\mu$ (a_μ is the Bohr radius of the meson orbit). Approximate wave-functions are given for the corresponding states. It is shown how to use these wave-functions in perturbation theory to find relativistic corrections and level shifts arising from a change of the shape of the charge distribution of the nucleus.

539.18

11491 DEPOLARIZATION OF MUONS IN μ-MESIC ATOMS WITH DEFORMED NUCLEI.
D.F.Zaretskii and V.M.Novikov.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1824-5 (Dec., 1959). In Russian.

This effect is considered for even-even nuclei and it is found that in addition to the depolarization caused by the spin—orbit interaction (Abstr. 8682 of 1959) present even in the case of spherical nuclei, there should be considerable further depolarization of the muons. P.K.Kabir

539.18 : 539.19

11492 μ-HYDROGEN MOLECULAR ION AND COLLISIONS BETWEEN μ-HYDROGEN ATOM AND PROTON, DEUTERON AND H ATOM.
Ta-You Wu, R.L.Rosenberg and H.Sandstrom.
Nuclear Phys., Vol. 39, No. 3, 432-59 (May (2), 1960).

To the order μ/M, the ratio of meson and proton masses, the following quantities are calculated: (1) the energy of the ground state of the molecular ion $(p-\mu-p)^+$; (2) the square of the meson wave-function at the position of a proton in $(p-\mu-p)^+$; (3) the "vibrational" level of $(p-\mu-p)^+$. The theory of direct and exchange collisions $(p-\mu) + d \to (p-\mu) + d$, $(p-\mu) + d \to (d-\mu) + p$ is given in terms of the coupling between the meson and nucleon motions. These cross-sections and that of the elastic scattering $(p-\mu) + p$ are calculated for energies corresponding to the temperature of liquid hydrogen. Also the cross-section of the $(p-\mu-p)^+$ formation process $(p-\mu) + H \to (p-\mu-p)^+ + e$ is calculated, leading to a value $\cong 1/18$ for the relative chance of μ-meson being found in the atomic $(p-\mu)$ system and in the molecular system $(p-\mu-p)^+$ in liquid hydrogen. This, together with (2), leads to the relative probability of ~ 6.3 of a μ-meson being captured by a proton in the molecular and the atomic state, if μ-capture in the hyperfine state $F = 0$ only (corresponding to an interaction V—A for the capture process) is assumed.

539.18

11493 RANGES OF μ-MESIC ATOMS IN HYDROGEN CHAMBERS. S.S.Gershtein.
Zh. eksper. teor. Fiz., Vol. 36, No. 4, 1309-11 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 927-8 (Oct., 1959).

Revised estimations suggest that a noticeable gap of about 0.5 mm should exist at the end of a μ^--meson track even in pure hydrogen. The $d_\mu + d$ cross-section is found to be about half of that calculated by Cohen et al. (Abstr. 7476 of 1958). E.J.Burge

539.18

11494 SOME RECENT DETERMINATIONS OF ATOMIC MASSES IN THE STRONTIUM— ZIRCONIUM REGION.
N.R.Isenor, R.C.Barber and H.E.Dichworth.
Canad. J. Phys., Vol. 38, No. 6, 819-23 (June, 1960).

A large double-focusing mass spectrometer has been used to obtain new values for the masses of Sr^{86}, Sr^{88}, and Zr^{90}. Mass differences calculated from these values are found to be in better agreement with nuclear transmutation information than were previous mass spectroscopically derived values.

539.18

11495 ISOTOPE ENRICHMENT WITH BROMINE BY ELECTROLYTIC CONDUCTION IN MOLTEN ZINC BROMIDE.
A.Lundén and A.Lodding.

Z. Naturforsch., Vol. 15a, No. 4, 320-2 (April, 1960). In German.

The concentration of Br^{79} in molten $ZnBr_2$ was increased by electrolysis. A mass effect (defined as the ratio between the relative difference of the ion mobilities and the relative difference of the mass) of $\mu = -0.035 \pm 0.002$ was found. R.Schnurmann

539.18

11496 THE ISOTOPE EFFECT IN THE ELECTROLYTIC TRANSPORT OF LITHIUM IONS IN SOLID LITHIUM SULPHATE. A.Lundén.

Z. Naturforsch., Vol. 15a, No. 4, 365 (April, 1960). In German.

Experiments in which a direct current was applied to a column of Li_2SO_4 at 630°C indicate an enrichment of Li^6 in a few of the subsequently sliced parts of the column. The self-diffusion coefficient of the lithium ions was estimated as 6×10^{-5} cm^2/sec. The mean current density during the experiments was 0.30 A/cm^2 and the total charge transfer during 5 hours was 1.27 ampere-hours. R.Schnurmann

539.18

11497 ENRICHMENT OF NITROGEN-15 BY CHEMICAL EXCHANGE OF NO WITH LIQUID N_2O_3.

E.U.Monse, W.Spindel, L.N.Kauder and T.I.Taylor.

J. chem. Phys., Vol. 32, No. 5, 1557-66 (May, 1960).

The characteristics of the two-phase exchange system: $N_2{}^{14}O_3(liq) + N^{15}O(gas) \rightleftarrows N^{14}N^{15}O_3(liq) + N^{14}P(gas)$ have been studied in laboratory exchange columns to evaluate its usefulness for concentrating N^{15}. The effective single stage separation factor α has been determined both by direct equilibration of liquid and gas phases, and by measuring the over-all separation in an exchange column as a function of the rate of product withdrawal. The factor α varies from 1.035 ± 0.005 at −14°C to 1.016 ± 0.004 at +14°C. The system is complicated by the presence of additional oxides of nitrogen in both phases, and it is not yet possible to evaluate the contributions of each of the individual molecular species to the effective separation factor. The over-all separations achieved at total reflux in a 40-stage bubble plate column corresponded to a maximum plate efficiency of ~60% at an interstage flow of ~50 mM $N/min\ cm^2$. Similarly, the separations obtained in a 95 cm column packed with stainless steel wire helices corresponded to stage heights of 1.1 and 1.2 cm for interstage flows of 23 and 31 mM $N/min\ cm^2$, respectively. A comparison of the present system with the nitric acid-nitric oxide exchange system indicates that approximately equal volumes of column would be required for the same isotope separation task in spite of a considerably lower α for the N_2O_3 system. This is due to the higher rate of exchange as evidenced by lower stage height. The favorable stage height for this process makes it possible to prepare highly concentrated N^{15} in shorter columns than those used for the nitric acid exchange.

539.18

11498 DIFFUSION IN THE GAS CENTRIFUGE. J.Strnad.

Period. math.-phys. astron. (Zagreb), Vol. 14, No. 4, 295-301 (1959). In German.

The equation for the separation of two isotopes in a gas centrifuge is solved by successive approximations on the assumption that the mass of the gas rotates with the centrifuge as if it were a rigid body. The time constant for the countercurrent gas centrifuge is very large compared to that of the diffusion constant for the ordinary centrifuge. R.Schnurmann

539.18

11499 SCATTERING EXPERIMENTS ON MOLECULAR BEAMS AT VARIOUS BEAM VELOCITIES. H.Pauly.

Z. Naturforsch., Vol. 15a, No. 3, 277-8 (March, 1960). In German.

The collision cross-section for a beam of potassium atoms colliding with nitrogen molecules has been determined experimentally. A mechanical velocity selector was used to select atoms of a given velocity for the investigations. The results show that the cross-section is of the form predicted by the theory of Massey and Mohr, in which it is assumed that the principal forces between the colliding bodies are those of attraction. A.E.I. Research Laboratory

539.18

11500 THE MASSEY PARAMETER IN THE THEORY OF ATOMIC COLLISIONS. G.F.Drukarev.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 847-8 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 603 (March, 1960).

The parameter a, which is a length of the order of atomic dimensions, is shown to be inversely proportional to the most probable momentum imparted in the forward scattering; this explains the empirical fact that a is mainly determined by the type of process, rather than by the nature of the colliding particles. J.Hawgoo

539.18

11501 THERMAL INELASTIC COLLISION PROCESSES. M.J.Seaton.

Rev. mod. Phys., Vol. 30, No. 3, 979-89, 990-1 (July, 1958).

The topics treated in this review include a summary of theoretical methods, excitation of H and H_2 by impact of protons, H atom H_2 molecules and electrons, comparison of Born and distorted wave approximations for atom-electron collisions, excitation of forbidden lines in p^q configurations, transitions between fine structure levels, and photoionization cross-sections for $2p^q$ configurations. 60 references. J.Hawgoo

539.18 : 539.1

11502 ELECTRON CAPTURE AND LOSS BY HYDROGEN ATOMS IN MOLECULAR HYDROGEN.

R.Curran and T.M.Donahue.

Phys. Rev., Vol. 118, No. 5, 1233-6 (June 1, 1960).

Measurements of the single electron capture and loss cross-sections for atomic hydrogen in molecular hydrogen are reported for atoms of energies 4 to 35 keV. Peaks in the loss cross-section are found which appear to be associated with the formation of negative ions in the target gas.

539.18 : 539.2 : 548.

MEASUREMENT OF ATOMIC DIFFERENTIAL SCATTERING CROSS-SECTIONS. See Abstr. 10309

539.1

11503 LOW ENERGY ELECTRON—HYDROGEN SCATTERING T.Ohmura, Y.Hara and T.Yamanouchi.

Progr. theor. Phys., Vol. 20, No. 1, 82-8 (July, 1958).

The effective range theory is developed for electron scattering by H atoms. The scattering length a_s and the effective range r_{0s} o the singlet state are determined by making use of the accurate solu tion of the H^- ion state, as: $a_s = 7.03$, $r_{0s} = 3.37$ (in atomic units). The scattering length a_t and the effective range r_{0t} of the triplet state are calculated from the zero energy solution by a variation-perturbation method. The results are: $a_t = 2.34$, $r_{0t} = 1.29$.

539.18 : 537.5

11504 SCATTERING OF ELECTRONS BY LIGHT ATOMS. A.N.Pilyankevich.

Zh. tekh. Fiz., Vol. 30, No. 2, 226-31 (Feb., 1960). In Russian.

Hartree and Hartree—Fock functions are employed in a numer cal calculation of the elastic and inelastic angular distributions for electrons (and X-rays) scattered by Be^{++}, Be, B, C^{4+}, C^{++} and C. Exchange effects are considered. Differences from published data are found in the small-angle region. S.Chom

539.18 : 537.53

11505 THE QUESTION OF ELECTRON SCATTERING IN THE ELECTRON MICROSCOPE. A.N.Pilyankevich.

Zh. tekh. Fiz., Vol. 30, No. 2, 232-8 (Feb., 1960). In Russian.

Using Mott's theory of electron scattering, the author calculat the differential and total scattering cross-sections for 60 keV electrons scattered elastically or inelastically by beryllium, boron, an carbon atoms, respectively. In order to do this the required atomi scattering factor was evaluated by means of Hartree functions. Th calculated cross-sections are compared with those of Lenz who us a different atomic scattering factor. For both elastic and inelastic scattering good agreement is found between the results of the two methods, at least for small angles (less than 10^{-3} radian) but not fo large. The author concludes further that Lenz's method gives mo accurate results for inelastic scattering than it does for elastic scattering. The results of the calculations are tabulated. T.Mulv

539.

11506 THE NON-ADDITIVITY OF LONDON—VAN DER WAA FORCES. L.I.Podlubnyi.

Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 888-9 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New Yor Vol. 37(10), No. 3, 633-4 (March, 1960).

An expression is obtained for the energy of the dispersive interaction of three hydrogen atoms in terms of their distance apart. W.J.Orville-Tho

539.18 : 539.14

11507 ISOTOPE SHIFT AND NUCLEAR DEFORMATIONS.

A.S.Meligy, S.Tadros and M.A.El-Wahab.

uclear Phys., Vol. 16, No. 1, 99-104 (April, 1960).

The expression for the isotope shift obtained in a previous paper y considering the nucleus as a sphere in which the charge distribuion has the trapezoidal shape is refined and then used to calculate he isotope shift constants for isotopic pairs for which experimental esults are available. The isotope shift constants due to nuclear leformation were also computed taking the deformations from the neasured B(E2) transition probabilities. The calculated and expeimental results of the isotope shifts of various elements are found o be in agreement within experimental uncertainties. On this evilence, the deformations of a number of nuclei were deduced from the sotope shift data.

539.18

11508 INVESTIGATION OF THE PROFILE OF THE CADMIUM RED LINE [6438 A], USING AN ATOMIC BEAM.

.A.Korolev, B.A.Kozlov and A.I.Odintsov.

ptika i Spektrosk., Vol. 7, No. 6, 721-4 (Dec. 1959). In Russian.

This profile was investigated using an atomic beam to excite he line, and a Fabry—Perot etalon with 15 cm separation between he plates. A considerable asymmetry of the profile was discovered. 'he half-width of the line was found to be $(11.8 \pm 0.5) \times 10^{-3}$ cm^{-1} this includes the instrument half-width). A theoretical interpretation f the profile is given. A.Tybulewicz

539.18

11509 LAMB SHIFTS OF THE GROUND STATES OF ^{4}He AND ^{3}He. G.Herzberg.

. Opt. Soc. Amer., Vol. 50, No. 4, 404 (April, 1960).

Paper presented at Joint Commission for Spectroscopy meeting, oscow, Aug., 1958. This paper is an abstract of one already pubished in Proc. Roy. Soc. (London) (Abstr. 7695 of 1960). Very recise values for the ionisation potentials of helium have been btained from redeterminations to within ±0.0005 A of the far ultraiolet lines. These are used in obtaining an experimental value for he Lamb shift. P.A.Young

539.18 : 539.19

11510 EMISSION SPECTRA OF THE DISCHARGE OBTAINED BY THE REUNION OF JETS EMITTED FROM FINE OINTS IN AIR. F.Cabannes and M.Skowronek.

. R. Acad. Sci. (Paris), Vol. 250, No. 13, 2344-6 (March 28, 1960). n French.

A multi-point electrode discharge was run in air (3 mA, 20 kV) nd the spectra recorded from it arose from two zones, one close o the point and the other extending into the surrounding space. pectral features arising from near the point are lines of N II and II and bands of N_2^+ (first negative system). Spectral features from he surrounding space are bands of N_2 (first and second positive ystems). No sign was seen of lines of N I and O I.
R.W.Nicholls

539.18

11511 RETARDATION AND K X-RAY RELATIVE INTENSITIES.

G.R.Taylor and W.B.Payne.

hys. Rev., Vol. 118, No. 6, 1549-51 (June 15, 1960).

The matrix elements for electric dipole transitions with etardation have been numerically evaluated for transitions between e 1s and higher discrete states of a single Dirac electron in a oulomb field. The results are used to calculate the relative intensies of the principal K X-ray lines in elements of high atomic umber. Comparison of the retarded and nonretarded matrix elements onfirms the earlier result for lead that the effect of retardation is ignificant in heavy elements only when the total angular momentum f the electron changes. Comparison with the experiments of eckman (Abstr. 6193 of 1955) indicate that this conclusion is correct, nd that in the $K\alpha_2$ to $K\alpha_1$ intensity ratio the effect of retardation s more significant than screening effects.

MOLECULES

539.19

11512 ELECTRON CAPTURE BY NEUTRAL MOLECULES.

R.E.Stanton.

J. chem. Phys., Vol. 32, No. 5, 1348-50 (May, 1960).

The problem of calculating the probability of electron capture by neutral molecules is analysed. It is shown that capture is possible only through the breakdown of the separation of nuclear and electronic motion in the Schrödinger equation, and that this is equivalent to the use of the nuclear kinetic energy as a perturbation operator. For diatomic molecules, it is found that capture is improbable except for those states of negative ions whose configuration contains at least as many MSO's of a given spin-symmetry type as the neutral molecule. Experimental verification of this result is found in the case of hydrogen.

539.19

11513 ESTIMATION OF FORCE CONSTANTS FROM THE ELECTRONIC ENERGY. R.Lefebvre.

Cahiers de Phys., Vol. 12, 154-60 (April, 1958). In French.

Brief review of the ways in which theoretical and semi-empirical calculations of electronic energy have been used to estimate the force constants of molecules, with particular reference to the effects of hybridization, resonance, etc. in determining the interaction between different vibrations. J.Hawgood

539.19

11514 TRANSFERABILITY OF UREY—BRADLEY FORCE CONSTANTS. I. CALCULATION OF FORCE CONSTANTS ON A DIGITAL COMPUTER. J Overend and J R.Scherer.

J. chem. Phys., Vol. 32, No. 5, 1289-95 (May, 1960).

An algorithm for the systematic calculation of Urey—Bradley force constants has been programmed for a digital computer (the Datatron 204). The secular equation is set up and solved in internal coordinates, the potential energy being transformed from Urey—Bradley space to internal-coordinate space by a matrix Z. This same matrix is also used to transform the Jacobian of λ with respect to the force constants from internal-coordinate to Urey—Bradley space, thereby allowing the direct determination of Urey—Bradley force constants. A method is described whereby the Z matrix and Wilson's G matrix may be set up by the computer from the geometrical parameters of the molecule.

539.19

11515 TRANSFERABILITY OF UREY—BRADLEY FORCE CONSTANTS. II. CARBONYL HALIDES AND RELATED MOLECULES. J.Overend and J.R.Scherer.

J. chem. Phys., Vol. 32, No. 5, 1296-1303 (May, 1960).

Urey—Bradley force constants have been fitted to the observed vibrational frequencies of COF_2, $COCl_2$, and $COBr_2$ by the method described in the previous paper. These force constants have been used to calculate the frequencies of COClF, COBrF, and COBrCl. Normal coordinates and the potential energy distribution among the various Urey—Bradley coordinates have also been calculated. It is found that, despite the fact that the carbonyl stretching frequencies fall over a range of 100 cm^{-1}, the carbonyl stretching force constant is essentially the same for all molecules in the carbonyl halide series.

539.19

11516 INTRODUCTION TO THE CALCULATION OF THE VIBRATION-ROTATION ENERGY OF MOLECULES WITH SPHERICAL SYMMETRY. J.Moret-Bailly.

Cahiers de Phys., Vol. 13, 476-94 (Dec., 1959). In French.

Describes in detail the calculation of the normal coordinates for XY_6 molecules of O_h symmetry, by way of the "oriented symmetry coordinates", and lists all non-zero coefficients in the vibration-rotation potential energy. Similar results are given for XY_4 molecules of T_d symmetry. J.Hawgood

539.19

11517 ON THE VALIDITY OF CENTRAL FORCE FIELDS IN MOLECULAR VIBRATIONS. A.Van de Vorst.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 10, 966-73 (1959). In French.

It is shown that the relations between force constants, which follow from the assumption of central force fields, are not satisfied by the experimental results for some molecules of the form XY_2 or XY_3. J.Hawgood

539.19

11518 VIBRATIONAL TRANSITION PROBABILITIES OF DIATOMIC MOLECULES: COLLECTED RESULTS. IV. BeO, BO, CH$^+$, CO, NO, SH, O$_2$, O$_2^+$.

R.W.Nicholls, P.A.Fraser, W.R.Jarmain and R.P.McEachran.
Astrophys. J., Vol. 13, No. 2, 399-406 (March, 1960).

For Pt III see Abstr. 8122 of 1955. Arrays of approximate vibrational transition probabilities (i.e., overlap integral squares or Franck-Condon factors) are presented for the following molecular transitions: BeO, $B^1\Sigma^+ \rightarrow X^1\Sigma^+$; $B^{11}O^{16}$ and $B^{10}O^{16}$, $A^2\Pi_i \rightarrow X^2\Sigma^+$ (α-system), CH$^+$, $A^1\Pi \rightarrow X^1\Sigma^+$; CO, $B^1\Sigma^+ \rightarrow A^1\Pi$ (Angstrom bands) and $b^3\Sigma^+ \rightarrow a^3\Pi_r$ (third positive); NO, $B^2\Pi_r \rightarrow X^2\Pi$ (β-system); SH and SD, $A^2\Sigma \rightarrow X^2\Pi_i$; O$_2$, $a^1\Delta_g \rightarrow X^3\Sigma_g^-$ (infrared atmospheric bands); O$_2^+$, $A^2\Pi_u \rightarrow X^2\Pi_g$ (second negative).

539.19

11519 INTENSITIES OF LINES IN A VIBRATION—ROTATION BAND. F.Legay.

Cahiers de Phys., Vol. 12, 416-36 (Nov., 1958). In French.

Theoretical. Gives general formulae for use in applying the method of Abstr. 7734 of 1957 to polyatomic molecules, taking vibration—rotation interactions into consideration to second order. The coefficients in the dipole moment transformation are given for polar and non-polar molecules, as are the rotational matrix elements. The linear molecule is examined in more detail. J.Hawgood

539.19

11520 ANALYSIS OF THE (1,0) BAND OF THE $^3\Pi_i$-$^3\Sigma^-$ SYSTEM OF PH. F.Legay.

Canad. J. Phys., Vol. 38, No. 6, 797-805 (June, 1960). In French.

This was photographed in absorption under high dispersion. Values for the rotational constants, the spin-coupling constant, and the vibrational interval $\Delta G'_{1/2}$ of the $^3\Pi_i$ state have been obtained. A study of the Λ-doubling shows the existence of a perturbation in the $^3\Pi_0$ state; it is not possible, however, to determine unambiguously the nature of the perturbing state.

539.19

11521 A NEW METHOD OF CALCULATING THE STATISTICAL WEIGHTS OF THE ROTATIONAL ENERGY LEVELS OF POLYATOMIC MOLECULES. E.D.Trifonov.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 74-6 (Nov. 1, 1959).
In Russian.

A further development and simplification of methods suggested by Wilson (Abstr. 2576 of 1935) and Godnev [Zhurnal Fizicheskoi Khimii, Vol. 19, 637 (1945); Vol. 20 897 (1946)] for the determination of these statistical weights (degeneracies). The method uses irreducible representations of a group of permutations (not of a point group of a molecule). A new definition of the spin modification of the molecule is given. F.Lachman

539.19

11522 VIBRATIONAL FREQUENCIES OF ALKALI HALIDE DIMERS. II. BENDING, SYMMETRIC STRETCH, AND B$_{1g}$ MODES. J.Berkowitz.

J. chem. Phys., Vol. 32, No. 5, 1521-2 (May, 1960).

Three of the normal vibrational frequencies of alkali halide dimers are calculated on the basis of the potential function for an ionic model. The results indicate that the out-of-plane bending mode may have a frequency almost as high as the in-plane stretching frequencies. A summary of the results of calculations for the six normal modes is presented.

539.19

11523 FORBIDDEN TRANSITIONS IN DIATOMIC MOLECULES. V. THE ROTATION-VIBRATION SPECTRUM OF THE HYDROGEN-DEUTERIDE (HD) MOLECULE.

R.A.Durie and G.Herzberg.
Canad. J. Phys., Vol. 38, No. 6, 806-18 (June, 1960).

For Pt IV see Abstr. 2287 of 1956. The 1-0, 2-0, and 3-0 rotation—vibration bands of HD were observed with a PbS infrared grating spectrometer and the 3-0 and 4-0 bands were photographed with a 21 ft concave grating spectrograph. From these spectra precise values of the vibrational and rotational constants of HD in its electronic ground state were determined. The variation of B_v and ΔG with v is similar to that recently established for H$_2$, that is, the values for v = 0 and 1 are markedly above the values corresponding to a linear extrapolation of the subsequent points. This leads to an uncertainty in the ω_e and B_e values which is much greater than that of the ΔG and B values. The (very low) intensity of the rotation—vibration spectrum of HD is in close agreement with that predicted. The decrease of intensity in going from 1-0 to 4-0 is strikingly slow. far slower than in a normal series of fundamental and overtone bands. This also is in qualitative agreement with theoretical expectation for a molecule like HD which does not have a dipole moment in its equilibrium position.

539.19

11524 POTENTIAL ENERGY CONSTANTS, ROTATIONAL DISTORTION CONSTANTS, AND THERMODYNAMIC PROPERTIES OF H$_2$C=C=O AND D$_2$C=C=O.

S.Sundaram and F.F.Cleveland.
J. chem. Phys., Vol. 32, No. 5, 1554-6 (May, 1960).

As a check on the assignments of the fundamentals of ketene (H$_2$C=C=O), a normal coordinate analysis has been carried out and and the constants for the general quadratic potential energy function for this molecule have been obtained. Using these constants, the fundamental vibrational wave-numbers for the deuteroketene have been calculated, and compared with the observed bands reported for this molecule. The moments of inertia tensor derivatives for the general X$_2$YXW molecule have been obtained. The rotational distortion constants for H$_2$C=C=O and D$_2$C=C=O have been determined The molar thermodynamic properties — heat content, free energy entropy, and heat capacity — have been calculated for both molecule for various temperatures from 100° to 1000° K at atmospheric pressure for the rigid-rotor, harmonic-oscillator approximation.

539.19

11525 POTENTIAL ENERGY CURVES FOR LITHIUM HYDRIDE R.J.Fallon, J.T.Vanderslice and E.A.Mason.

J. chem. Phys., Vol. 32, No. 5, 1453-5 (May, 1960).

Potential energy curves for the $X^1\Sigma^+$, $A^1\Sigma^+$, and $B^1\Pi$ states of LiH have been calculated by the Rydberg-Klein—Rees method. The results are in agreement with curves previously obtained by Crawfor and Jorgensen and by Rosenbaum using different methods. As a check the somewhat peculiar curve for the $A^1\Sigma^+$ state has also been calculated for LiD, and agrees with the LiH curve to about 1%. The curve obtained theoretically by Karo and Olson for the $X^1\Sigma^+$ and $A^1\Sigma^+$ state are only in fair agreement with the experimental results.

539.19 : 541.18

INFRA-RED SPECTRA OF SORBED WATER. See Abstr. 10376

539.19 : 541.18

INFRARED STUDIES OF WATER ABSORBED ON ALKALI HALIDES. See Abstr. 10375

539.19

11526 STUDY OF PYROSULPHITES AND PYROSELENITES BY INFRARED ABSORPTION SPECTROSCOPY.

C.Rocchiccioli.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2347-9 (March 28, 1960).
In French.

Infrared and Raman studies on solid Na$_2$S$_2$O$_5$ and K$_2$S$_2$O$_5$ and S$_2$O$_5^{--}$ ions in solution together with similar studies of solid Na$_2$Se$_2$O$_5$, BaSe$_2$O$_5$, CaSe$_2$O$_5$, CaSe$_2$O$_5$.2H$_2$O lead to the hypothesis of the structure: O$_2$X-O-XO$_2$ (X = S or Se) for the cation X$_2$O$_5$ in each case. R.W.Nicholls

539.19

11527 THE INFLUENCE OF TEMPERATURE AND PRESSURE ON THE RAMAN SPECTRUM OF NITROGEN.

G.V.Mikhailov.
Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1368-73 (May, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 974-8 (Nov., 1959).

The rotational structure of the Q-branch of the vibrational band of the Raman spectrum of nitrogen was studied. The dissimilar nature of the impact broadening of the vibrational and rotational lines of the spectra is established. The following effective collision radii determining the Raman spectrum line broadening were found: for the Q-branch of the vibrational band, ρ_ν = 0.43 A; for the purely rotational band lines ρ_ω = 3.9 A. It is shown that the experimental results do not contradict the impact theory of spectral line broadening.

539.19

11528 RAMAN SPECTRA OF METAL CARBONYL COMPOUNDS. II. RAMAN SPECTRA, STRUCTURE, AND FORCE CONSTANTS OF COBALT AND IRON TETRACARBONYLAT ANIONS. H.Stammreich, K.Kawai, Y.Tavares, P.Krumholz,

J.Behmoiras and S.Bril.

J. chem. Phys., Vol. 32, No. 5, 1482-7 (May, 1960).

For previous work, see Abstr. 6747 of 1959. The Raman spectra of the ions $Co(CO)_4^-$, $Fe(CO)_4^{2-}$, and $HFe(CO)_4^-$ were studied in aqueous solutions of the corresponding sodium salts. The spectra of $Co(CO)_4^-$ and $Fe(CO)_4^{2-}$, excited by the helium radiations 5875.6 and 6678.1 A are in full agreement with the expected T_d symmetry of these ions; all observed frequencies were assigned to fundamental vibrational modes. A normal coordinate treatment was carried out under the assumption of a simplified valence force field model making use of only two interaction constants. The values of the fundamental frequencies of the tetrahedral ions, calculated by means of the potential constants of this model, were found to be in satisfactory agreement with the observed Raman shifts. The Raman spectrum of $HFe(CO)_4^-$, put in correlation with that of $Fe(CO)_4^{2-}$, points strongly to a C_{3v} symmetry of the former ion.

539.19 : 539.18

EMISSION SPECTRA OF THE DISCHARGE OBTAINED BY THE REUNION OF JETS EMITTED FROM FINE POINTS IN AIR.

See Abstr. 11510

539.19

11529 CONTRIBUTIONS TO THE STUDY OF ELECTRONIC SPECTRA OF DIATOMIC OXIDES. I. SPECTRUM OF LaO.

S.Hautecler and B.Rosen.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 8, 790-803 (1959). In French.

Electronic transitions which could account for the observed spectrum of LaO in the range 3450-9730 A are proposed. Some experimental details are given and previous relevant work reviewed.

G.I.W.Llewelyn

539.19

11530 ELECTRONIC INTERACTION IN THE FREE-ELECTRON NETWORK MODEL FOR CONJUGATED SYSTEMS. III. SPECTRA OF HYDROCARBONS OTHER THAN EVEN ALTERNANTS.

N.S.Ham.

J. chem. Phys., Vol. 32, No. 5, 1445-8 (May, 1960).

For Pt II, see Abstr. 7597 of 1956. The effects on spectral calculations of including interaction between the ground and lower excited states are investigated by the free-electron model for some hydrocarbons in which such interaction should occur in principle, viz., phenanthrene, perinaphthenylium cation, and azulene. The resultant lowering of the ground state energy is less than 150 cm^{-1} when the ground and excited states have equal charge densities. Fo azulene, with unequal charge densities, the interaction is about 4000 cm^{-1}, and the agreement with experiment for the two lower singlet levels is considerably improved. The free-electron calculations for the nonalternant ions $C_5H_5^-$ and $C_7H_7^+$ are also reported.

539.19

11531 THE POLYGON METHOD FOR THE GRAPHICAL STUDY OF DETERMINANTS. APPLICATIONS TO PROBLEMS OF THEORETICAL CHEMISTRY.

I.Samuel.

Cahiers de Phys., Vol. 12, 92-109 (March, 1958). In French.

See Abstr. 3419 of 1958. The method is used for calculations on the electronic structure of naphthalene and two nitrogen-substituted derivatives, separate calculations being described, respectively including and neglecting overlap integrals. The results differ little, except for the free valences, which are better calculated by neglecting overlap.

J.Hawgood

539.19

11532 ELECTRON CORRELATION AND MOLECULAR SHAPE.

R.J.Gillespie.

Canad. J. Chem., Vol. 38, No. 6, 818-26 (June, 1960).

It is proposed that the arrangements of the electron pairs in the valency shell of a central atom of a polyatomic molecule can be predicted by considering the equilibrium arrangements of similar particles on the surface of a sphere with an appropriate law of force between the particles. The arrangements resulting from an inverse square law of force, corresponding to electrostatic repulsions, and a force which is proportional to $1/r^n$ where n is large, corresponding to Pauli forces, are considered specifically. It is shown that the arrangements predicted agree with those found experimentally for molecules containing only non-transitional elements. The possible arrangements for seven, eight, and nine pairs of electrons in a valency shell are discussed in detail. A method is suggested for predicting the arrangements of electron pairs in valency shells containing one pairs which can occupy alternative non-equivalent positions. The effect of the interactions of electron pairs on bond lengths in certain molecules is discussed. The extension of the same principles to molecules containing transitional elements is briefly outlined.

539.19

11533 EIGENVALUES OF π-ELECTRONS IN A POTENTIAL BOX WITH AN EVEN NUMBER OF BARRIERS n.

S.M.Yazykova.

Optika i Spektrosk., Vol. 7, No. 6, 729-32 (Dec., 1959). In Russian.

When the metallic model with infinite walls is used for molecules with incomplete alignment of single and double bonds, the potential of the molecular skeleton is assumed to be periodic. Employing this assumption and Veselov and Rekasheva's model (1954), the equation for the determination of the eigenvalues of π-electrons in a potential box with an even number of barriers, n, was obtained in a general form. The barriers were taken to correspond to single bonds in a molecule and $n > 2$. The calculations were carried out for both even and odd eigenfunctions. The formulae obtained were used to find the energy levels of a polyene, $C_{10}H_{12}$. The calculated levels yielded an absorption line at 384 mμ, compared with an experimental value of 346 mμ.

A.Tybulewicz

539.19

11534 THEORY OF SATURATION IN ELECTRON SPIN RESONANCE SPECTRA.

M.J.Stephen and G.K.Fraenkel.

J. chem. Phys., Vol. 32, No. 5, 1435-44 (May, 1960).

A theory of saturation in electron spin resonance spectra exhibiting hyperfine splitting is presented. This theory is used to study the saturation of free radical spectra in solution, and a variety of relaxation processes are investigated. It is shown that motional modulation of the intramolecular electron-nuclear anisotropic dipole—dipole interaction introduces a relation between the saturation parameters and the hyperfine components that varies symmetrically about the centre of the spectrum and causes a smaller degree of relaxation for the components in the central portion of the spectrum than for those in the wings. This relaxation mechanism introduces a greater dependence on nuclear spin state for radicals with several magnetic nuclei than for radicals with only one such nucleus. It is also shown that a cross term between this intramolecular dipolar interaction and motional modulation of the anisotropic g tensor introduces a relaxation that varies linearly from one side of the spectrum to the other. Numerical values of the relaxation-induced transition probabilities are estimated for the benzene negative ion, and tables are given from which saturation factors can be computed for a variety of conditions for several different spin systems. The relation between the spin-lattice relaxation time T_1 and the para meters which determine saturation is discussed, and it is pointed out that these quantities are not equivalent in systems exhibiting cross relaxation.

539.19

11535 SPIN DISTRIBUTION IN NAPHTHALENE NEGATIVE ION.

T.R.Tuttle, Jr.

J. chem. Phys., Vol. 32, No. 5, 1579 (May, 1960).

Hyperfine structure in the electron spin resonance of the naphthalene negative ion due to C^{13} in 53% abundance in one β position was observed and analysed in terms of π-electron densities.

E.F.W.Seymour

539.19

11536 CALCULATION OF THE COUPLING TERMS NEGLECTED IN PERFORMING THE BORN—OPPENHEIMER SEPARATION FOR THE HYDROGEN MOLECULE ION.

D.W.Jepsen and J.O.Hirschfelder.

J. chem. Phys., Vol. 32, No. 5, 1323-35 (May, 1960).

A method is given for calculating the coupling between the nuclear and electronic motion in the hydrogen molecule ion using the exact wave-functions. Calculations are carried out for the transition $1s\sigma$-$2s\sigma$ and compared with values obtained from simple approximate methods. Estimates are made of the cross-sections for excitation and capture into the 2s state during a proton—hydrogen atom collision, using approximate H_2^+ wave-functions to describe the state during collision. Finally, it is shown that a Born—Oppenheimer separation carried out in relative coordinates should be slightly more accurate than the usual treatment using fixed space coordinates. Two different types of relative coordinates suggest themselves for use at different ranges of internuclear separation.

539.19

11537 CLASSIFICATION OF MOLECULAR TERMS USING THE TOTAL NUCLEAR SPIN. E.G.Kaplan.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1050-3 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 37(10), No. 4, 747-9 (April, 1960).

A method is suggested for determination of the nuclear multiplicities of molecular terms for nuclei of arbitrary spin. The relation between the Young schemes and a total spin, on the one hand, and the permutation group and the point symmetry group of the molecule, on the other, is used.

539.19

11538 PROTON N.M.R. SPECTRA OF THE N,N-DIMETHYLFORMAMIDE, N-METHYLFORMAMIDE, AND N,N-DIMETHYLACETAMIDE.

V.J.Kowalewski and D.G.de Kowalewski.

J. chem. Phys., Vol. 32, No. 4, 1272-3 (April, 1960).

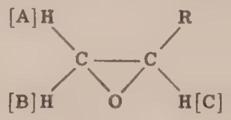
The n.m.r. proton spectrum of the N,N-dimethylformamide has been previously reported to consist of one resonance line corresponding to the formyl hydrogen and two methyl resonances corresponding to the non-equivalent methyl groups. A further splitting has now been observed in both peaks corresponding to different values of J couplings between the formyl hydrogen and the two methyl groups. These long range interactions are observed at about the highest resolution obtainable using a Varian instrument at 40 Mc/s. J.M.Baker

539.19

11539 NUCLEAR MAGNETIC RESONANCE SPECTRA OF SOME SIMPLE EPOXIDES. C.A.Reilly and J.D.Swalen.

J. chem. Phys., Vol. 32, No. 5, 1378-85 (May, 1960).

High resolution n.m.r. spectra of four epoxides were observed at 40 Mc/s and analysed. These epoxides are of the type



where R is a phenyl group (styrene oxide), a cyanide group (glycidonitrile), an acetyl group (1,2-epoxy-3-butanone), and a carboxyl group (glycidic acid). For each molecule the spin–spin coupling constants and nuclear magnetic screening parameters for the A, B, and C protons were derived from the experimentally determined energy levels. The method for obtaining numerical values for the energy levels from the spectra is described fully. ABK and AA'K approximations as well as an iterative ABC method of solution are described and illustrated. Corresponding coupling constants are found to be about the same in all four molecules with $J_{AB} = 5.8 \pm 0.5$ c/s $J_{AC} = 2.2 \pm 0.5$ c/s and $J_{BC} = 4.6 \pm 0.5$ c/s. However, the variations from molecule to molecule are considerably greater than the estimated precision of ±0.05 c/s. The ABX approximation is shown to be inadequate either for the precise determination of the constants or for the calculation of relative intensities. As compared with the iterated ABC solution, the ABK or AA'K approximation leads to good values for the constants and adequately describes the relative intensities.

539.19

11540 CONTRIBUTION TO THE STUDY OF MOLECULAR WAVE FUNCTIONS. C.Vroelant.

Cahiers de Phys., Vol. 12, 341-66 (Sept., 1958). In French.

For previous parts, See Abstr. 7444 of 1959 and 1493 of 1960. It is shown that the mean position of an electron is not a useful concept for characterization of a molecular wave function, but that the most probable electronic configuration is useful in this way. Degeneracy and "quasi-degeneracy" of this configuration are studied, and qualitative laws obtained which describe its structure. These laws are very closely related to the empirical Lewis rules for simple molecules, while the "quasi-degeneracy" feature describes delocalized bonds. It is suggested that approximate wave functions based on Gaussian functions should be used, their parameters being determined primarily by the most probable configuration. J.Hawgood

539.19

11541 SPIN DENSITIES IN DIMESITYLMETHYL.

A.D.McLachlan.

J. chem. Phys., Vol. 32, No. 5, 1488-9 (May, 1960).

A simple valence bond calculation indicates that if the dimesityl-methyl radical were planar large unpaired spin densities would appear on the ring methyl groups giving a spectrum about 130 gauss wide. A perturbation calculation, assuming that the molecule is very twisted, gives spin densities $\rho_1 = 1.000$, $\rho_2 = -0.069$, $\rho_3 = 0.054$, $\rho_4 = -0.040$, $\rho_5 = 0.043$ on the carbon atoms, numbered from the centre outwards.

539.19 : 77

ANALYSIS OF ELECTRON DIFFRACTION PHOTOGRAPHS OF MOLECULAR STRUCTURE. See Abstr. 10791

539.19

11542 THE VARIATION OF DIPOLE MOMENT WITH INTERATOMIC DISTANCE. A.Laforgue.

Cahiers de Phys., Vol. 13, 87-97 (March, 1959). In French.

The electric moment, μ, of a molecule depends upon the distance apart of the nuclei, τ, and hence varies during a vibration. The theoretical work done on this problem is briefly reviewed and a discussion given of the author's own contributions. Curves of μ against τ are given for LiH and LiF. W.J.Orville-Thomas

539.19

11543 DETERMINATION OF THE DIPOLE MOMENT FUNCTION FROM INFRARED BAND INTENSITIES OF DIATOMIC MOLECULES. R.Herman and R.J.Rubin.

J. chem. Phys., Vol. 32, No. 5, 1393-7 (May, 1960).

A discussion is given of the relations which exist among vibrational matrix elements for diatomic molecules represented as Morse oscillators. This is done according to the wave-function approximation of Trischka and Salwen. It is shown how the matrix element of the dipole moment $M_v^{v'}$ is related to the matrix elements M_0^i where $v' - v \leq i \leq v' + v$ with $v' > v$. This relation is examined for the case of the 1-2 band of HCl. It is also shown how the matrix element M_0^1 for DCl can be related to the matrix elements of HCl. Finally, the influence of the vibration-rotation interaction is incorporated in the wave-function approximation. In an example, it is shown that the matrix element $M_{0,J}^{1,J+1}$ can be expressed in terms of the set of matrix elements $\{M_{0,0}^{i,1}\}$, $i = 0, 1, \ldots$

539.19

11544 VIRIAL COEFFICIENTS AND INTERMOLECULAR FORCES OF HYDROCARBONS.

J.F.Connolly and G.A.Kandalic.

Phys. of Fluids, Vol. 3, No. 3, 463-7 (May-June, 1960).

The second virial coefficient of the gaseous equation of state is not very sensitive to molecular shape. Therefore, its temperature dependence is not usually a good criterion for distinguishing between intermolecular potentials. However, if the molecules are highly asymmetric and if the temperature range is broad, the effect of asymmetry should become apparent. By measuring 2nd virial coefficients of benzene and n-octane at high temperatures, and combining these results with low temperature values from the literature, the Kihara potential is shown to be superior to that of Lennard-Jones, for nonspherical molecules. The Kihara potential is also applied to the normal paraffins from propane through heptane.

539.19 : 535.33 : 532.7

INTERMOLECULAR FORCES AND SOLVENT EFFECTS. See Abstr. 10669-70

539.19

11545 SOME NOTES ON MOLECULAR COMPLEXES BETWEEN IODINE AND POLYNUCLEAR AROMATIC HYDROCARBONS. M.Chowdhury and S.Basu.

J. chem. Phys., Vol. 32, No. 5, 1450-2 (May, 1960).

It has been observed that when iodine concentration is high in a mixture of iodine and polynuclear aromatic hydrocarbon in carbon tetrachloride, the spectral data may be interpreted on the assumption of 2 : 1 molecular complex formation between iodine and aromatic hydrocarbon. The equilibrium constants for 2 : 1 complexes were, however, found to be much higher than those of the corresponding 1 : 1 complexes and they were further found to be independent of the nature of the hydrocarbon. Interpretation of the experimental data based on contact charge transfer appears to be much more reasonable in the present case.

539.19

11546 THE THEORY OF LIGHT SCATTERING AND X-RAY LOW ANGLE SCATTERING BY SEMI-STIFF CHAIN MOLECULES. A.R.Stokes.

Proc. Phys. Soc., Vol. 75, Pt 4, 489-97 (April 1, 1960).

Numerical values of the normalized intensity of scattering by semi-stiff chain molecules are calculated. The method depends on the calculation of the inverse Laplace transform of an expression first obtained by Daniels (1952), which is also derived in this paper by an alternative method. The values obtained from this calculation are compared with those given by Peterlin's formula (1953). The normalized intensity is also calculated for a polydisperse system of chains of constant stiffness parameter.

539.19

11547 THE STRUCTURE OF HAEMOGLOBIN. VII. DETERMINATION OF PHASE ANGLES IN THE NON-CENTROSYMMETRIC [100] ZONE. D.M.Blow.

Proc. Roy. Soc. A, Vol. 247, 302-36 (Sept. 30, 1958).

For Pt VI see Abstr. 10670 of 1954. A Fourier centrosymmetric projection down the [010] axis of horse haemoglobin was given previously. As a first step towards the three-dimensional analysis, the projection down [100] has now been attacked. This projection is non-centrosymmetric, and arbitrary phase angles have had to be determined. All the fundamental problems of a three-dimensional study are met, but only a small number of reflexions need to be dealt with. The isomorphous replacement method has been used successfully with three mercury derivatives of haemoglobin. This provided a test of new methods for finding the vectors relating heavy atoms. Particular attention has been given to estimation of errors, and to their effect on the results. Further information about the phase has been derived from anomalous scattering by the mercury atoms, using CrKα and CuKα radiation. By combining these results, the phases of most reflexions out to a spacing of about 6 A have been determined with a standard error of about 25°. The resulting electron density projection shows peaks up to four times the estimated standard error. The prospects for three-dimensional structure analysis at 6 A resolution are favourable. If the polypeptide chain is coiled in the α-form, the contrast should be sufficient for it to show up throughout its length.

539.19 : 539.18

ELECTRON CAPTURE AND LOSS BY HYDROGEN ATOMS IN MOLECULAR HYDROGEN. See Abstr. 11502

539.19 : 539.18

μ-HYDROGEN MOLECULAR ION. See Abstr. 11492

SOLID-STATE PHYSICS

539.2

11548 EQUATION OF STATE FOR NINETEEN METALLIC ELEMENTS FROM SHOCK-WAVE MEASUREMENTS TO TWO MEGABARS. R.G.McQueen and S.P.Marsh.

J. appl. Phys., Vol. 31, No. 7, 1253-69 (July, 1960).

Plane-wave explosive systems were used to accelerate thin metal plates to high velocities. Shock pressures resulting from the collision of these driver plates with a stationary target plate are approximately three times greater than the original shock pressure in the driver plate. The photographic flash-gap technique was used to record velocities associated with the shock waves. The new experimental data extend the Hugoniot loci into the one- to two-megabar region for 19 metallic elements: Ag, Au, Cd, Co, Cr, Cu, Mo, Ni, Pb, Sn, Th, Ti, Tl, V, W, Zn, Bi, Fe, Sb. The Hugoniot P, V, E data were extended to a more complete P, V, E, T equation of state by use of the Mie—Grüneisen theory. The thermodynamic variable $\gamma = V(\partial P/\partial E)_V$, necessary for this extension, was obtained by solving the Dugdale—MacDonald relation.

539.2

11549 INTERPOLATED EQUATIONS OF STATE FOR METALS UNDER VERY HIGH PRESSURES.

S.B.Kormer and V.D.Urlin.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 3, 542-5 (March 21, 1960). In Russian.

Following Bardeen (Abstr. 3068 of 1938) the authors expand the cold adiabatics, applicable to metals under pressures of the order of 10^9 atm, as a power series in relative pressures. The first six coefficients of this expansion are determined and are tabulated for Al, Ni, Cu, Zn, Ag, Sn, Au, Pb, Mg, Cr, Zr, Ta and Pt. Also, some adiabatics are plotted. J.K.Skwirzynski

539.2

11550 STATE EQUATIONS OF ALUMINIUM, COPPER AND LEAD IN THE HIGH-PRESSURE REGION.

L.V.Al'tshuler, S.B.Kormer, A.A.Bakanova and R.F.Trunin.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 790-8 (March, 1960). In Russian.

A state equation for metals is considered which differs from the Mie—Gruneisen solid-state equation by allowing for thermal electron components in the energy and pressure. Some new data on dynamic compression of metals are presented which are employed to deduce state equations for aluminium, copper and lead in the high-pressure region.

539.2

11551 QUANTUM-MECHANICAL CALCULATION OF PRESSURE IN SOLIDS.

G.M.Gandel'man and E.S.Pavlovskii.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1176-82 (April, 1960). In Russian.

A quantum-mechanical generalization of the virial theorem is deduced for the pressure in a solid at the absolute zero. Its use in the spherical cell approximation is considered in detail.

539.2

11552 ON THE PROBLEM OF MELTING OF GERMANIUM AND SILICON. T.A.Kontorova.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1761-3 (Nov., 1959). In Russian.

Reported experiments indicate that germanium and silicon acquire metallic properties on melting. It is shown that this change of properties is due to a loss of the definite spatial orientation by the sp^3-hybrid "valence bridges" and due to an increase of the mean number of neighbours (the coordination number). A.Tybulewicz

539.2

11553 THE CALCULATION OF INTEGRALS IN THE METHOD OF EQUIVALENT ORBITS AND THE ESTIMATION OF THE PARAMETERS OF THE VALENCY ZONES IN SEMICONDUCTORS OF THE TYPE AIIIBV. A.A.Nran'yan.

Fiz. tverdogo Tela, Vol. 2, No. 3, 474-81 (March, 1960). In Russian.

Estimated integrals of the exchange function of equivalent orbits connected by valency strips are necessary for finding the valence zones of definite AIIIBV compounds and of diamond-type crystals. Functions of the equivalent orbits are assumed to be of the form of a linear combination of two sp^3 functions directed to each other from neighbouring atoms. Atomic functions are assumed as in Abstr. 469 of 1960. By means of the magnitudes of the integrals thus found, the effective masses of three sorts of holes and the widths of valency and the supplementary forbidden zones of various AIIIBV compounds are calculated. The regularities in the changes of these parameters of the zone structure with transition from one substance to another are analysed. A.L.Mackay

539.2

11554 DIRECT CATION—CATION INTERACTIONS IN PRIMARILY IONIC SOLIDS. J.B.Goodenough.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 359S-361S (May, 1960).

It is pointed out that there is considerable experimental evidence for direct cation—cation interactions in several primarily ionic solids containing transition-element cations with outer-electron configuration nd^m, where $m \leq 5$. Competitive indirect (cation—anion—cation) interactions are dominant if $m = 5$. Nevertheless, if cation-occupied octahedra share a common face, as in the corundum and NiAs-type structures, the direct (cation—cation) interactions may also significantly influence the physical properties of the material. If octahedral-site cations have $m \leq 3$, the cation—anion—cation interactions are weak and cation- -cation interactions may be dominant. The consequences of cation- -cation interactions are described and shown to be quite distinct from those of cation—anion—cation interactions so that the dominant mechanism can usually be distinguished. Data for several illustrative materials are presented.

539.2

11555 PENETRATION DEPTH OF SURFACE EFFECTS IN MOLECULAR CRYSTALS.

B.J.Alder, J.R.Vaisnys and G.Jura.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 182-9 (Oct., 1959).

In the semi-infinite molecular crystal the interplanar distances perpendicular to the surface are allowed to assume their equilibrium value. By minimizing the energy of the system it is shown that the first interplanar distance increases by 2.5%, the second by 0.6%, the third by 0.2%, and the fourth by 0.08%. It can be shown that this expansion over the normal distance in an infinite crystal falls off as one over the cube of the distance from the surface. On the other hand, the surface energy is shown to be only slightly affected by these deeper distance perturbations. The change in interplanar distances is also calculated for various uniformly distorted semi-infinite crystals.

539.2

11556 SEMI-EMPIRICAL DETERMINATION OF THE BORN—MAYER CONSTANTS OF CUBIC CLOSED-SHELL METALS, PARTICULARLY OF COPPER. E.Mann and A.Seeger.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 314-25 (Feb., 1960). In German.

The non-electrostatic interaction between the closed shells of the ion cores in the noble metals is usually described by a Born—Mayer energy per ion-pair of the form $\phi(r) = A \exp[-B(r/r_0 - 1)]$, where r denotes the separation between the neighbouring atoms and r_0 the equilibrium separation. The parameters A and B are here determined semi-empirically by the following methods: (a) from the ordinary (linear) elastic shear constants (following Huntington and Seitz); (b) from the pressure dependence of the shear moduli; (c) from the bulk modulus, utilizing a theoretical expression for the energy of the ground state, which accounts, within a few per cent, for the energy of cohesion of copper; (d) from the (non-linear) volume-pressure relation as recently determined in shock wave experiments.

539.2

11557 THE FORMATION ENERGY AND LATTICE DISTORTION OF INTERSTITIAL ATOMS AND VACANCIES IN CUBIC CLOSED-SHELL CRYSTALS, PARTICULARLY IN COPPER.

A.Seeger and E.Mann.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 326-40 (Feb., 1960). In German.

The semi-empirical model of the previous paper (see preceding abstract) using Born—Mayer forces between neighbouring ions is employed to calculate the energies of formation and the volume expansion due to interstitials and vacancies in f.c.c. metals, in particular copper. The most important new feature is the purposeful use that is made of Born's theory of crystal lattices. In the case of copper, the coupling parameters appearing in this theory are known from experiment. The contribution to these coupling parameters from the Born—Mayer interaction (which varies rapidly with interatomic distance) is subtracted out. The remainder is due to the action of the valence electrons and varies much less with the separation of the atoms. Thus a representation of the interatomic forces was obtained that should remain valid even for the large distortions occurring in the environment of an interstitial atom. This representation has the additional advantage of satisfying all stability requirements. Furthermore, the employment of the theory of crystal lattices enables the transition to be made between the continuum region and the atomic region of the strain field practically without introducing arbitrary elements. The main results for copper are as follows: energy of formation of an interstitial $E_Z = 3$ eV, of a vacancy $E_L = 1$ eV; volume expansion by a Frenkel pair $\Delta V = 1.3$ atomic volumes.

539.2 : 539.12

11558 ON THE BREADTHS OF ANNIHILATION LINES IN COPPER AND IN GOLD. B.Średniawa.

Helv. phys. Acta, Vol. 33, No. 2, 131-42 (1960).

The line breadths are calculated on the basis of two models: (1) the Fermi gas model of conduction electrons and Cu^+ or Au^+ ions, and (2) the model where the atoms exist complete in the crystal, but where, however, owing to the influence of the crystal, the outer shell 4s of Cu is so compressed that it overlaps with the 3d shell (and for Au, the 6s shell overlaps with the 5d shell). The breadths due to conducting electrons and the electrons in different shells of the Cu and Au ions are calculated. By a comparison of the results with experimental data, it is shown that in the first model the contribution of conducting electrons to the breadth of the annihilation line is negligible. For both models, the largest contribution stems from the most external complete shell but in Cu about 5%, and in Au about 40-50% of the annihilations take place in the next inner shells of the atoms.

539.2 : 539.12

11559 LEAD K ABSORPTION EDGE FOR μ-MESON MASS DETERMINATION. A.J.Bearden.

Phys. Rev. Letters, Vol. 4, No. 5, 240-1 (March 1, 1960).

A measurement of the shape of the K X-ray absorption edge in lead is described, and discussed in relation to the determination of the μ-meson mass from the 3D-2P mesonic X-ray lines of phosphorus.

A.Ashmore

539.2 : 539.14

11560 RECOILLESS RAYLEIGH SCATTERING IN SOLIDS. C.Tzara and R.Barloutaud.

Phys. Rev. Letters, Vol. 4, No. 8, 405-6 (April 15, 1960).

The Debye—Waller factor φ_T for the reduction in intensity of Bragg X-ray scattering by a solid at temperature T was determined for Pt, Al, graphite and paraffin by detecting the proportion of recoilless γ-rays using the Mössbauer effect. The Rayleigh scattering was studied at 80° and 300°K. The agreement between the experimental and calculated values of φ_T at 80°K is good.

E.A.Sanderson

539.2 : 539.14

11561 EVIDENCE FOR QUADRUPOLE INTERACTION OF Fe^{57m}, AND INFLUENCE OF CHEMICAL BINDING ON NUCLEAR GAMMA-RAY ENERGY. O.C.Kistner and A.W.Sunyar.

Phys. Rev. Letters, Vol. 4, No. 8, 412-15 (April 15, 1960).

The Mössbauer effect is used to determine the quadrupole coupling for the $\frac{3}{2}$-excited state and the energy shift of the 14.4 keV nuclear gamma-ray of Fe^{57} bound in Fe_2O_3. In order to fit the observed data an energy shift $\Delta E = (2.26 \pm 0.15) \times 10^{-8}$ eV is required between the centre of gravity of the absorption lines of Fe^{57} in Fe_2O_3 and the emission line of Fe^{57} bound in stainless steel. Further necessary shifts, $\epsilon = \pm 5.75 \times 10^{-9}$ eV (+ve for $|m| = \frac{1}{2}$, –ve for $|m| = \frac{3}{2}$), in the individual hyperfine levels of the excited state are attributed to quadrupole interaction The measurements give values of 0.611 ± 0.005 cm/sec and 0.345 ± 0.003 cm/sec, respectively, for the splitting parameters of the ground and excited states of Fe^{57} in Fe_2O_3 and the internal magnetic field in antiferromagnetic Fe_2O_3 is found to be 1.547 ± 0.022 times as large as that in ferromagnetic iron. The relative intensities of the absorption lines confirm the inverted hyperfine pattern for the $\frac{3}{2}$ state. Possible reasons for the energy shift ΔE due to chemical environment effects are discussed.

E.A.Sanderson

Lattice Dynamics

539.2

11562 ELEMENTARY METHOD FOR THE CALCULATION OF THE LATTICE ENERGIES OF THE NaCl CRYSTAL. I.

F.Fáthy and F.Bukovszky.

Acta phys. Hungar., Vol. 8, No. 1-2, 89-107 (1957).

By developing Kossel's theory and model of crystal growth, an elementary method is given to compute the lattice energies of hexagonal, heteropolar crystals. The method leads in a simple way to the correct value of the Madelung constant.

539.2

11563 ELEMENTARY METHOD FOR THE CALCULATION OF THE LATTICE ENERGIES OF THE NaCl CRYSTAL. II.

F.Fáthy and F.Bukovszky.

Acta phys. Hungar., Vol. 9, No. 3, 275-83 (1959).

The method of Pt I is further developed. The binding energy is given of an ion situated sideways at the end of the (half) ion chain which is infinite in one direction, and that which is infinite in two directions.

539.2

11564 [ENERGY] SPECTRUM OF AN IDEAL FERMI GAS IN A LATTICE. A.B.Almazov.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 3, 529-31 (March 21, 1960). In Russian.

Systems are considered which can be described in terms of independent particles or quasi-particles and which have the symmetry o a cubic lattice. Expressions of the particle energy levels are obtained as functions of the wave vectors. The energy density for electrons in solid sodium is evaluated and compared with experimental results.

R.Eisenschitz

539.2

11565 THE FREQUENCY DISTRIBUTION FUNCTION OF VIBRATIONS OF ATOMS IN A CRYSTALLINE LATTICE.

A.B.Almazov.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1844 (Dec., 1959). In Russian.

Refers to the author's earlier work on cubic crystals and points out that only in the case of face-centred cubic lattice the frequency distribution function is of the Debye type (this cannot be found experimentally). A.Tybulewicz

539.2

11566 INTERMOLECULAR COUPLING OF VIBRATIONS IN MOLECULAR CRYSTALS. D.A.Dows.

J. chem. Phys., Vol. 32, No. 5, 1342-7 (May, 1960).

The connection between intermolecular potentials energies and the unit cell vibrational frequencies in molecular crystals is summarized. Details of the treatment of potentials which can be written as functions of intermolecular atom–atom distances are developed. The frequencies of vibration of methyl chloride in the crystal are treated. Dipole–dipole interactions are insufficient to explain the observed splittings. For vibrations which are primarily hydrogen motions, an intermolecular hydrogen–hydrogen repulsion potential accounts satisfactorily for the observed effects.

539.2

11567 SOME REMARKS ABOUT FREQUENCY SPECTRA OF CRYSTAL LATTICES. J.Peretti.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 216-32 (Feb., 1960).

The general construction of the frequency distribution of a crystal lattice when the force constants between atoms are known is treated. The intermediate step is to consider a function F(z), of the complex variable z, which is expressible in terms of the force constants in a compact form. The frequency spectrum g(x) itself is, apart from a multiplicative constant, the imaginary part of F(z). This general formalism is applied, first, to calculate g(x) for special lattices; secondly, to investigate the singularities of the spectrum; thirdly, to derive a low-temperature expansion of the spectrum; and fourthly, to investigate the analytical nature of one-dimensional frequency spectra.

539.2

11568 ON THE VIBRATION OF DISORDERED LINEAR LATTICE. II. J.Hori.

Progr. theor. Phys., Vol. 18, No. 4, 367-74 (Oct., 1957).

The exact eigenfrequency distribution of the Poisson lattice containing few isotopic impurities at random positions is calculated by he matrix method developed in Pt I (Abstr. 11555 of 1959) and by Kerner (Abstr. 6040 of 1956). Within the original band, this is found o coincide with that obtained in Pt I from the average eigenvalue quation $\langle \text{Trace } H \rangle_{AV} = 2$. This justifies the use of the average igenvalue equation for the Poisson lattice, at least within the band. The distribution function obtained shows in addition that outside the and there appears a narrow "impurity band". Secondly, the exact verage eigenvalue equation for non-Poisson lattice is calculated, howing that, on the average, the eigenfrequency distribution is the ame as that of the regular lattice except that the limiting frequency s shifted corresponding to the average increase or decrease of the tomic mass. Finally, the validity of the ergodic assumption is examined, with a negative answer. The actual lattices may, therefore, ave an eigenfrequency-distribution which is markedly different rom the average distribution.

539.2

11569 EFFECTS OF DEFECTS ON LATTICE VIBRATIONS. THERMODYNAMICAL PROPERTIES.

K.Yamahuzi and T.Tanaka.

Progr. theor. Phys., Vol. 20, No. 3, 327-55 (Sept., 1958).

Thermodynamical quantities relating to the vibrational frequenies of imperfect lattices are calculated. Using the method of ontour integrals, the expressions for the difference of vibrational ree energies between imperfect and perfect lattices are derived. hese are given in two forms, applicable to high and low temperatures. s an example of the practical application of these formulae, n-imensional simple lattices with defects are treated, and the simple ubic lattice and the linear chain are investigated in detail. Although n this example a simplified model of the actual defect is considered, may be sufficient to discuss the general features of the thermoynamical properties of imperfect lattices. See also following bstract.

539.2

11570 VIBRATIONAL THERMODYNAMIC PROPERTIES OF LATTICES WITH DEFECTS. I. THE LINEAR LATTICE.

J.Mahanty, A.A.Maradudin and G.H.Weiss.

Progr. theor. Phys., Vol. 20, No. 3, 369-94 (Sept., 1958).

Several methods of analysing vibrational properties of crystal lattices with defects are developed. Integral expressions for additive functions of normal mode frequencies are derived following the work of Montroll and collaborators. It is shown that the Helmholtz free energy can be evaluated at high and low temperatures without performing the integrations. The methods presented are valid for lattices of all odd dimensions, although specific results are presented here for one-dimensional monatomic and diatomic lattices. Using a method similar to that developed by Lifshitz, it is shown that the properties of a lattice with defects can be expanded in a series of powers of the concentration of defects. The coefficient of the n-th power depends on the properties of a lattice with n defects. Examples of such expansions are given. An exact expression for the frequency distribution function of a monatomic linear chain with an isotope defect is given.

539.2

11571 THERMODYNAMIC AVERAGING OF THE DISPLACEMENT FUNCTION OF ATOMS IN AN IMPERFECT CRYSTAL LATTICE. V.I.Peresada.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1141-7 (April, 1960). In Russian.

In investigations of scattering of X-rays or slow neutrons by atomic systems it becomes necessary to average thermodynamically the function exp $[i\vec{q}\vec{u}_R]$, where $\vec{q}$ is a constant vector and $\vec{u}_R$ is the displacement of the $\vec{R}$-th atom. In the case of small oscillations the thermodynamic mean of an arbitrary function $F(\vec{q}\vec{u}_R)$ is uniquely defined by the quadratic fluctuation $D(\vec{n}, \vec{R}, T)$ of the displacement of the $\vec{R}$-th atom in the direction of a vector $\vec{n} = \vec{q}/q$ (T is the absolute temperature of the system). A method is presented for computation of the quantity $D(\vec{n}, \vec{R}, T)$ for an infinite perfect crystal with a finite number of local defects. An asymptotic expression was obtained for the function $(\vec{n}, \vec{R}, T)$ at large distances from the defects. The asymptotic value is determined by the lattice and the nature of the defects. This method is applicable to other problems as well.

539.2

11572 RESONANCE ABSORPTION IN SOLID CYCLOHEXANE. R.A.Rasmussen.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 774-5 (June, 1960).

Measured values of the acoustic absorption coefficient for monocrystalline cyclohexane in the range of from 3 to 8 Mc/s are presented and compared with those predicted by the "resonance" absorption theory proposed by Liebermann (Abstr. 5455, 10713 of 1959).

539.2

11573 ATTENUATION OF SOUND IN A GERMANIUM CRYSTAL AT ULTRA-HIGH FREQUENCIES AND LOW TEMPERATURES. E.R.Dobbs, B.B.Chick and R.Truell.

Phys. Rev. Letters, Vol. 3, No. 7, 332-4 (Oct. 1, 1959).

The attenuation of ultrasonic waves in a germanium crystal by the pulse echo method was measured in the range 50-600 Mc/s and 1.5°-300°K. Corrections are made to separate from the intrinsic attenuation losses due to diffraction, reflection at the end faces and for the small thermoelastic loss in the case of longitudinal waves. The curve of attenuation against temperature shows a sharp rise at about 50°K which is related to phonon–phonon scattering loss.

G.Mott

539.2

11574 PHOTOSENSITIVE ULTRASONIC ATTENUATION IN CdS. H.D.Nine.

Phys. Rev. Letters, Vol. 4, No. 7, 359-61 (April 1, 1960).

The attenuation of compressional waves (10 to 200 Mc/s) propagated along the c-axis was observed to be affected by the intensity and wavelength of light incident on the crystal. J.Jarzyński

539.2

11575 A CONTRIBUTION TO THE THEORY OF ABSORPTION OF ULTRASOUND IN METALS. V.P.Silin.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 977-83 (March, 1960). In Russian.

Considers the absorption of sound at low temperatures where electrons govern the absorption and at sufficiently high frequencies when the wavelength of sound is small compared with the electron mean free path. Anisotropy of the Fermi surface and the interaction due to the electromagnetic field, as well as that due to changes in electron energy caused by deformation of the lattice are taken into account. It is shown that, in the region of wavelengths which are approximately equal to the anomalous skin layer depth at a given sound frequency, a decrease in the ratio of the absorption coefficient to the frequency should be observed with increase of the frequency.

539.2

11576 ANISOTROPY OF THE ABSORPTION OF ULTRASOUND IN METALS IN A MAGNETIC FIELD.

A.A.Galkin and A.P.Korolyuk.

Zh. eksper.teor. Fiz., Vol. 36, No. 4, 1307-9 (April, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 4, 925-7 (Oct., 1959).

The electronic component of longitudinal ultrasonic absorption, at frequencies between 17 and 70 Mc/s, has been studied in tin and zinc single crystals at liquid helium temperatures as a function both of magnitude and of direction (relative to crystal axes) of a transverse magnetic field. Specimen results are presented as graphs, showing both oscillations with change of magnitude of field and anisotropy in rotation diagrams at constant field. The effect of field direction on the oscillations is briefly discussed. L.Mackinnon

539.2

11577 OSCILLATIONS IN THE ABSORPTION COEFFICIENT OF SOUND IN TIN AT LOW TEMPERATURES.

A.A.Galkin and A.P.Korolyuk.

Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 310-12 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 219-20 (Jan., 1960).

Longitudinal 70 Mc/s ultrasonic waves have been propagated along both the two- and four-fold axes of symmetry of a tin single crystal at 4.2°K, and the resulting absorption has been studied for various magnetic fields perpendicular and parallel to the direction of propagation of the sound. The results for fields perpendicular to the sound are described and discussed in more detail than in the previous communication (preceding abstract) but those for the field parallel to the sound are not given in any detail although singular points in the absorption-field curve have been found as predicted by the theory of Gurevitch (Abstr. 7865 of 1960). L.Mackinnon

539.2 : 532.7

ULTRASONIC STUDIES IN MELTS AND SOLUTIONS. See Abstr. 10659

539.2

11578 INFLUENCE OF DIPOLE-DIPOLE COUPLING ON SPECIFIC HEAT OF A PARAMAGNETIC SALT.

R.I.Joseph and J.H.Van Vleck.

J. chem. Phys., Vol. 32, No. 5, 1573-4 (May, 1960).

In a previous paper (Abstr. 2707 of 1937) Van Vleck evaluated the zero field partition function and specific heat as a power series in T^{-1}. This paper notes that the previous T^{-4} term was incorrect and recalculates it for the special case of a simple cubic lattice. J.W.Leech

539.2

11579 ON THE ANOMALOUS THERMODYNAMIC PROPERTIES OF ICE. P.A.Giguère.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 249-56 (Oct., 1959).

Comparison of the measured heat capacity of ice with that of crystalline hydrogen peroxide reveals some unusual features in the former. For instance, the translational heat capacity of ordinary ice below 100°K bears no resemblance to a Debye curve. In that range the values of θ_D increase considerably with temperature: from 192° at 10°K up to 318° at ~ 100°K for ordinary ice, and from 180° at 15°K up to 300° at ~ 80°K for heavy (D_2O) ice. Various criteria point to the high-temperature limiting values of θ_D as the normal ones. Like the zero-point entropy, the anomalously large heat capacity of ice below 100°K must be a consequence of frozen-in disorder. Calculations of the thermodynamic functions of ice and crystalline hydrogen peroxide, based partly on spectroscopic data, support the view that the order—disorder transition in ice would be of the λ type, with a λ point in the neighbourhood of 80°K. On structural grounds, the occurrence of Bjerrum defects in ice is ruled out.

539.2

11580 THE DEBYE TEMPERATURE OF VITREOUS SILICA. O.L.Anderson.

J. Phys. Chem. Solids, Vol. 12, No. 1, 41-52 (Dec., 1959).

It is shown that the low-temperature elastic constants of vitreous silica can account for only a small fraction of the low-temperature heat capacity. On the other hand, for quartz the elastic constants account for all the low-temperature heat capacity. The data for cristobalite are not complete, but there is evidence to suggest that the anomaly also exists in this phase of silica. It is shown that the long-wave vibrational properties of vitreous silica, optical and acoustical, are consistent with the analogous properties of ionic solids.

539.2

11581 THE LOW-TEMPERATURE HEAT CAPACITY AND THE RAMAN AND BRILLOUIN SPECTRA OF VITREOUS SILICA.

P.Flubacher, A.J.Leadbetter, J.A.Morrison and B.P.Stoicheff.

J. Phys. Chem. Solids, Vol. 12, No. 1, 53-65 (Dec., 1959).

The heat capacity of vitreous silica has been measured between 2.3 and 19°K with an estimated accuracy of ±2% at the lowest temperatures and ±0.5% for $10°K < T < 19°K$. The temperature dependence of the heat capacity at the lowest temperature is very much greater than that observed for simple crystals. Moreover, if Θ_0 is determined in the usual manner by a smooth extrapolation to $T^2 = 0$ of a graph of C/T^3 against T^2, it appears to be less than $\Theta_{(elastic)}$ by about 20%. In order to interpret this unusual behaviour, some spectroscopic studies of vitreous silica have been made. Velocities of transverse and longitudinal waves of frequencies of 3.3 and 5.0×10^{10} sec^{-1} respectively have been determined from measured Brillouin spectra; these agree excellently with velocities determined by acoustic methods at a frequency of 10^7 sec^{-1}. The Raman spectrum has been photographed; its outstanding feature is an intense continuum which extends from 560 cm^{-1} down to 8 cm^{-1}. These spectroscopic results suggest that the excess heat capacity of vitreous silica is contributed by optical modes of very low frequency. The observed heat capacity can be accounted for quantitatively on this basis.

539.2 : 536.6

11582 A HEAT CAPACITY STUDY OF THE MOVEMENT OF THE AMMONIUM ION IN AMMONIUM STANNICHLORIDE AND STANNIBROMIDE BY COMPARISON OF THE HEAT CAPACITIES OF THE AMMONIUM, RUBIDIUM AND POTASSIUM SALTS.

R.G.S.Morfee, L.A.K.Staveley, S.T.Walters and D.L.Wigley.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 132-44 (May, 1960).

The heat capacity of the following six salts has been measured throughout the range 20°-300°K: ammonium, rubidium and potassium stannichlorides, ammonium, rubidium and stannibromides. By comparison of the heat capacities of the ammonium and rubidium salts (which are isomorphous), that part of the heat capacity due to the torsional oscillations of the ammonium ions has been separated, and for both the stannichloride and the stannibromide is found to be decreasing as room temperature is approached from below, reaching at 298°K a value roughly halfway between that for free rotation and for classical torsional oscillations. This implies that the ammonium ions are restricted rotators prevented from freely rotating by comparatively low energy barriers. The bearing of this on the charge distribution in the stannihalide ions has been considered. Gradual transitions have been found in ammonium stannibromide and potassium stannichloride. Whereas the latter is apparently a simple λ-type transition with an entropy change of ~ 1.13 e.u., that in the stannibromide has an entropy change of ~ 4.5 e.u. and appears to be a transition of some complexity. The possibility is considered that the transition in potassium stannichloride might be due to the availability to the anion of two alternative orientations.

539.2

11583 SPECIFIC HEAT OF DILUTE ALLOYS.

W.Marshall.

Phys. Rev., Vol. 118, No. 6, 1519-23 (June 15, 1960).

Zimmerman has recently observed that the addition of Mn to Cu produces a large contribution to the specific heat which, at low temperatures, is linear in temperature and independent of Mn concentration. It is shown that: (a) this remarkable result can be explained in terms of the well-known Ruderman—Kittel—Yosida spin—spin coupling via conduction electrons; (b) the specific heat results of Beck et al. on FeV and FeCr alloys are probably of essentially the same origin as those of Zimmerman on Cu—Mn; (c) that there are serious objections to the mechanism of antiferromagnetism postulated by Overhauser (Abstr. 1810 of 1960) and used by him to explain the specific heat results. In contrast to the Overhauser theory, no new concepts are involved and it is suggested that the large specific heat comes from a small fraction of Mn spins which, because of the random nature of the alloy, happen to be in small effective fields and therefore not strictly aligned. The theory depends on two plausible assumptions which have not, at present, been proved rigorously valid.

539.2

11584 THE SPECIFIC HEAT OF MERCURY BELOW 1°K.

B.B.Goodman.

Physica, Vol. 24, Supplement, S149 (Sept., 1958). In French.

Low Temperature Physics Conference (see Abstr. 7017 of 1960). A brief report of measurements giving the values $\Theta_0 = 80 \pm 4^\circ$K, $\gamma = (2.1 \pm 0.1) \times 10^{-3}$ joule mole^{-1} deg^{-2}. R.G.Chambers

539.2

11585 EXACT CALCULATION OF THE SPECIFIC HEAT FOR A PARTICULAR MODEL OF A SOLID.

B.Dreyfus, Y.Ayant and J.Peretti.

Physica, Vol. 24, Supplement, S180 (Sept., 1958). In French.

Low Temperature Physics Conference (see Abstr. 7017 of 1960). Brief report of a technique for evaluating $\Theta(T)$ directly, without calculating the frequency spectrum, for a simple cubic lattice with nearest-neighbour forces. R.G.Chambers

539.2

11586 THE ANOMALOUS SPECIFIC HEAT OF, AND NUCLEAR RESONANCE IN, CRYSTALLINE HYDROGEN IN CONNECTION WITH NEW DATA CONCERNING ITS STRUCTURE.

S.S.Dukhin.

Zh. eksper. teor. Fiz., Vol. 37, No. 5, 1486-8 (Nov., 1959). In Russian.

Lazarev and co-workers (1959) have shown that the structure of solid hydrogen can be regarded as either a tetragonal lattice or a hexagonal one differing somewhat from the close-packed hexagonal lattice formerly ascribed to it. It should be possible to distinguish between these two by four specific heat and nuclear resonance methods. (1) Improved numerical constants in Nakamura's formula for C_V are calculated for the case of the tetragonal lattice. (2) Numerical values of the anisotropy of the nuclear resonance line widths for the two lattices are obtained using a formula due to van Vleck. (3) The spin—lattice relaxation time is calculated using a theory due to Moriya and Motizuki. (4) Numerical values for the line widths of orthodeuterium, but not paradeuterium, are obtained using the same van Vleck formula as in (2). See Abstr. 949 of 1949; 6819 of 1956.
N.Davy

539.2 : 536.4

11587 THE THERMAL EXPANSION OF A SILICON SINGLE CRYSTAL.

R.R.Birss and R.J.Horne.

Proc. Phys. Soc., Vol. 75, Pt 5, 793-5 (May, 1960).

The specimen consisted of a rod 2.3 cm long with axis parallel to ⟨111⟩ crystallographic direction. The ends were ground flat and perpendicular to the axis. An optical lever method was used and the expansion relative to fused silica was measured from −195° to +100° C. The apparatus and method is fully described. The results shown graphically are compared with those of Gibbons (Abstr. 3385 of 1959), confirming a negative Grüneisen factor below 150° C.
S.Weintroub

539.2 : 536.2 : 537.3

11588 LOW-TEMPERATURE TRANSPORT PROPERTIES OF COMMERCIAL METALS AND ALLOYS. IV. REACTOR GRADE Be, Mo, AND W.

R.L.Powell, J.L.Harden and E.F.Gibson.

J. appl. Phys., Vol. 31, No. 7, 1221-4 (July, 1960).

For Pt II-III see Abstr. 7857-8. The thermal conductivity, electrical resistivity, Lorenz ratio, and thermoelectric power are given in the temperature range 4°-120° K for four reactor-grade metals: beryllium with sample axis parallel to the pressing axis, beryllium with sample axis perpendicular to the pressing axis, molybdenum, and tungsten, the latter two doped with ThO_2. Within the given temperature range the molybdenum and tungsten show slight maxima in thermal conductivity, the beryllium does not. The various components of the electronic and lattice thermal conductivities and resistivities are resolved. The residual electrical resistivities are, respectively, 0.64, 1.01, 0.57, and 0.16×10^{-6} ohm cm. The Lorenz ratios for molybdenum and tungsten show both maxima and minima and are always below the Sommerfeld value. The ratios for the beryllium samples have broad maxima and generally are above the Sommerfeld value. The thermoelectric powers of the samples with respect to pure copper are negative for the higher temperatures and positive for the lower temperatures.

539.2 : 536.2

11589 THE EFFECT OF TIN AND BISMUTH IMPURITIES ON THE THERMAL CONDUCTIVITY OF SELENIUM.

N.A.Aliev and N.I.Ibragimov.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1668-9 (Nov., 1959). In Russian.

Selenium of 99.994% purity and selenium with 0.25, 0.50, 0.75, 1.00% by weight of tin or bismuth was used. One per cent of tin raised the thermal conductivity of both amorphous and crystalline selenium by about 10%, and 1% of bismuth raised it by 30%.
A.Tybulewicz

539.2 : 536.2

11590 EXCITATION PROCESSES IN CERAMICS AND ANOMALOUS INCREASE IN THERMAL CONDUCTIVITY AT ELEVATED TEMPERATURES.

D.H.Whitmore.

J. appl. Phys., Vol. 31, No. 6, 1109-12 (June, 1960).

The problem of the anomalous increase in the observed thermal conductivity of single-phase ceramics at high temperatures has been considered. At temperatures above the onset of this anomalous rise, account has been taken of the possibility that phonon, electronic, and radiative heat transfer, as well as transport of thermal energy by electron—hole pairs, excitons, and dissociated gas molecules, may operate simultaneously and individually contribute significantly to the total heat flow. On the basis of reliable conductivity data on nonporous monocrystals of single-phase ceramics, estimations have been made of the magnitudes of these high-temperature components which reveal that excited states of low excitation energy may occur in certain ceramics. In these instances, such excited energy-carrying states are able to diffuse down the temperature gradient in the specimen thereby producing a non-negligible contribution to its observed thermal conductivity.

539.2

11591 LOW-TEMPERATURE LATTICE HEAT CONDUCTION IN HIGH-RESISTIVITY ALLOYS.

J.E.Zimmerman.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 299-302 (Oct., 1959).

It is shown theoretically that for high-resistivity alloys the lattice thermal conductivity K_l is proportional to T, the absolute temperature, and to ρ_0, the residual electrical resistivity. At higher temperatures (but $< \theta/20$) or lower resistivities, K_l becomes proportional to T^2 and independent of ρ_0; this is the behaviour generally observed in alloys for which ρ_0 is less than $\sim 10 \mu\Omega$cm. The theory is verified by measurements on a series of silver—antimony alloys, in which ρ_0 varies between 12 and 40 $\mu\Omega$ cm.

539.2

11592 QUANTUM STATISTICAL MECHANICS OF ELECTRON—PHONON SYSTEMS. II. SPECIFIC HEAT AND SPIN PARAMAGNETIC SUSCEPTIBILITY

H.Ichimura.

Progr. theor. Phys., Vol. 20, No. 4, 415-38 (Oct., 1958).

The effects of electron—phonon interaction on the specific heat and spin paramagnetic susceptibility of conduction electrons in metals are investigated using the method proposed in Pt I (Abstr. 8300 of 1956). Calculations up to terms of the second order of the interaction Hamiltonian show that the specific heat is increased and spin paramagnetic susceptibility is decreased by the presence of the electron—phonon interaction; the effect is much larger in the former than in the latter.

539.2

11593 ELECTRICAL, OPTICAL AND ELASTIC PROPERTIES OF DIAMOND-TYPE CRYSTALS. IV. INTERACTION BETWEEN CONDUCTION ELECTRONS AND LATTICE VIBRATIONS.

V.S.Mashkevich.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1736-42 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1237-41 (Dec., 1959).

For Pt III, see Abstr. 12069 of 1959. Considers the interaction produced between conduction electrons and lattice vibrations by the polarization due to these vibrations. The possibility of the existence of polaron states is investigated. The electron mobility is evaluated.

539.2

11594 THEORY OF COLLECTIVE OSCILLATION OF ELECTRONS IN SOLIDS. Y.J.Ichikawa.

Progr. theor. Phys., Vol. 18, No. 3, 247-63 (Sept., 1957).

A general formulation of the collective oscillation of electrons in solids is developed to take into account fully effects of ion-core potential. Based on the second quantized scheme of the many-body system, the collective component of density fluctuation is examined carefully and it is shown that a set of the collective normal coordinates can be defined under specified conditions. The many-electron Hamiltonian is transformed into the Hamiltonian of the collective field and of the electrons with a modified electron—electron interaction and the interaction Hamiltonian between the collective field and the electrons. Formulae for the generalized "plasma" frequency and the dispersion relation, are derived.

539.2 : 537.533

COLLECTIVE LOSSES OF FAST ELECTRONS IN THEIR PASSAGE THROUGH MATTER. See Abstr. 9091

539.2

11595 ON THE SUBSIDIARY CONDITIONS IN THE BOHM—PINES THEORY OF ELECTRON PLASMA. H.Kanazawa.

Progr. theor. Phys., Vol. 18, No. 3, 287-94 (Sept., 1957).

The subsidiary conditions in the Bohm—Pines theory (Abstr. 1278 of 1954) are too stringent. There is no normalizable wavefunction which satisfies the subsidiary conditions. The subsidiary conditions are modified and it is shown that the mathematical inconsistency in the Bohm—Pines theory may be removed.

539.2

11596 ELECTRON RESONANCE IN CROSSED ELECTRIC AND MAGNETIC FIELDS. I.M.Lifshits and M.I.Kaganov.

Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 555-6 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 392-3 (Feb., 1960).

If the dependence of electron energy on momentum is not quadratic, then the frequency of motion depends on the magnitude of the electric field. The effect could probably not be observed in metals but should be observable in semiconductors. D.J.Oliver

539.2

11597 THE ENERGY SPECTRUM OF HOLES IN CRYSTALS OF THE DIAMOND TYPE. K.Ya.Shtivel'man.

Fiz. tverdovo Tela, Vol. 2, No. 3, 499-501 (March, 1960). In Russian.

The theoretical treatment includes a spin—orbit coupling and shows that the energy is split into four zones; the lowest one, an s-state, is unaffected by the spin—orbit coupling. A cubic equation is given for the energies of the other three zones and solutions given for small, large and intermediate values of k, the pseudomomentum; the zone shapes and effective masses are discussed. D.J.Huntley

539.2

11598 THEORY OF THE LOW-LYING STATES OF SOME RARE EARTH COMPOUNDS. G.T.Trammell.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 362S-363S (May, 1960).

The "electrostatic" crystalline torques acting on the magnetic ions in the rare earth nitrides are possibly larger than those due to exchange. Some of the consequences of this are discussed.

539.2

11599 ON THE CALCULATION OF CRYSTAL FIELD PARAMETERS. J.C.Phillips.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 226-30 (Oct., 1959).

A new method is presented for calculating crystal field splittings. The method includes the effect of orthogonalization to ligand orbitals by grouping the latter terms into an effective repulsive potential. It is shown by a very general argument that this repulsive potential should cancel to high accuracy the excess attractive potential obtained when point-ion ligands are replaced by distributed-charge ligands. This result therefore provides a qualitative justification for the empirical success of the Van Vleck point-ion approximation for crystal fields.

539.2

11600 CRYSTAL FIELD SPLITTING OF ENERGY LEVELS OF THULIUM ETHYLSULFATE. J.B.Gruber and G.Conway.

J. chem. Phys., Vol. 32, No. 5, 1531-4 (May, 1960).

The operator-equivalent method is employed to calculate the theoretical splitting of electronic energy levels $^3P_2$, $^1D_2$, $^3F_2$, $^3F_3$, $^3F_4$, $^1G_4$, and $^3H_6$ in $Tm(C_2H_5SO_4)_3.9H_2O$. Intermediate field corrections are made to α, β, and γ. A first-order perturbation treatment on $Tm^{+3}(4f^{12})$ in C_{3h} symmetry, using crystal-field parameters $A_2^0\langle r^2\rangle = 13\ cm^{-1}$, $A_4^0\langle r^4\rangle = -80\ cm^{-1}$, $A_6^0\langle r^6\rangle = -32\ cm^{-1}$, and $A_6^6\langle r^6\rangle = 300\ cm^{-1}$, predicts the position of the crystal quantum states.

539.2

11601 ON THE GROUND LEVEL SPLITTING OF Mn^{++} AND Fe^{+++} IN NEARLY CUBIC CRYSTALLINE FIELD.

H.Watanabe.

Progr. theor. Phys., Vol. 18, No. 4, 405-20 (Oct., 1957).

The ground-level splitting and g-factor of Mn^{2+} and Fe^{3+} in a nearly cubic crystalline field, with a small axially symmetric field superposed on it, are studied by higher-order perturbation calculations. It is shown that the electronic energy levels arising from the configuration half-filled with electrons are unsplit under the linear effect of crystalline potentials, but can be split by the effects of even powers of them. Various higher-order processes involving crystalline potential, spin—orbit coupling and magnetic spin—spin interaction within an ion that are supposed to be dominant in the ground-level splitting and the g-factor deviation, are formulated and order-of-magnitude discussions are given for them.

539.2

11602 THEORY OF THE ENERGY LEVELS OF DONOR—ACCEPTOR PAIRS. F.E.Williams.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 265-75 (Feb., 1960).

The electronic energy levels of the donor—acceptor pair are investigated theoretically in the effective mass approximation in a way similar to the Heitler—London treatment of the hydrogen molecule. The cores are approximated by point charges; the medium, by a continuous dielectric; and the two-particle wave function, by a single product of the separated donor and acceptor wave functions. No exchange integral arises, and the total ionization energy decrease with increasing degree of association. The analysis is generalized to pairs whose electron and hole masses are unequal and to pairs in polar media. The optical transition energies involved in the creation and evolved in the annihilation of the bound exciton are calculated. The effect of state of ionization on the electron and hole levels is determined. In highly-associated pairs the ionization of the electron or hole greatly reduced the ionization energy of the remaining particle. The analysis is applied to zinc sulphide containing Group IIIB donors and Group IB acceptors, and supports the identification of the long-wavelength luminescent emission as the transition between the ground states of donor and acceptor in quite highly-associated pairs. Other possible applications are suggested.

539.2

11603 THE THEORY OF ELEMENTARY EXCITATIONS IN ATOMIC CRYSTALS.

A.E.Glauberman, V.V.Vladimirov and I.V.Stasyuk.

Fiz. tverdogo Tela, Vol. 2, No. 1, 133-43 (Jan., 1960). In Russian.

Develops a theoretical treatment of the polar model that avoids the limitations of previous theories, namely, the statistics of the elementary quasi-particle excitations, the construction of the Hamiltonian in terms of the quasi-particle operators and the averaging over phonons. These difficulties are overcome and also terms higher than quadratic describing kinetic effects can be discussed. R.Berman

539.2

11604 ON THE EXCITON PROBLEM IN INSULATING CRYSTALS. Y.Takeuti.

Progr. theor. Phys., Vol. 18, No. 4, 421-36 (Oct., 1957).

The general problem of configuration interactions for the excited states in ideal insulators is investigated by solving a difference equation which is derived in the same way as in the scattering problem. It is shown that the general picture of excitons falls into three categories: deep case, shallow case, and hydrogenic case, according to different conditions under which the difference equation is to be solved approximately. The structures of the bands of both the singlet and triplet excitons are investigated in these three cases with particular emphasis on the deep case. The solution derived is intermediate between the "atomic" and "continuum" models hitherto proposed.

539.

11605 CALCULATION OF THE POLARON EFFECT IN THE THEORY OF MULTIPHONON THERMAL IONIZATION.

Yu.E.Perlin.

Fiz. tverdogo Tela, Vol. 2, No. 2, 242-54 (Feb., 1960). In Russian.

Discusses the thermal transition between a discrete energy evel of an F-centre and a polaron state of the continuous spectrum n an ionic crystal, as a result of weak interaction between the elecron and longitudinal acoustic waves. This occurs with reasonable robability when there is strong interaction between the electron and he longitudinal optical branch. The calculated probability of this onization process in NaCl is less than observed, so that other ossible mechanisms must be considered. R.Berman

539.2

11606 ON SOME OBSERVABLE PROPERTIES OF LONGITUDINAL EXCITONS.

J.J.Hopfield and D.G.Thomas.

. Phys. Chem. Solids, Vol. 12, No. 3-4, 276-84 (Feb., 1960).

The continuum theory of the dielectric properties of direct xcitons is briefly developed for uniaxial crystals (optically isotropic rystals are a special case). The finite energy difference between ongitudinal and transverse excitons can quench the linear Zeeman ffect in certain geometries in both isotropic and uniaxial crystals. n uniaxial crystals it should be possible to observe "longitudinal" xcitons in optical absorption. These "longitudinal" excitons are xpected to have energies and oscillator strengths which depend trongly on the direction of propagation of the exciton. "Longitudinal" xcitons are not observable along the principal axes of a crystal. Optical absorption measurements carried out on hexagonal ZnO have emonstrated the existence of these excitons. Even for the rather omplicated case of ZnO, in which two interacting longitudinal excitons re observed, the simple continuum theory is shown to agree quanitatively with experiment.

539.2

11607 EXCITON ENERGY LEVELS IN GERMANIUM AND SILICON.

T.P.McLean and R.Loudon.

. Phys. Chem. Solids, Vol. 13, No. 1-2, 1-9 (May, 1960).

The energies of the lowest-lying levels of the direct exciton in ermanium and the indirect excitons in germanium and silicon have een calculated in the effective-mass approximation by a variational rocedure. These energies are compared with the experimental alues obtained from optical absorption experiments.

539.2

11608 THEORY OF LINE-SHAPES OF THE EXCITON ABSORPTION BANDS.

Y.Toyozawa.

Progr. theor. Phys., Vol. 20, No. 1, 53-81 (July, 1958).

The theory is developed with the help of the generating function ethod. When the exciton-lattice coupling is weak, and the exciton ffective mass is small, the absorption band is of a Lorentzian hape, provided that the temperature T is not too high. The halfalue width H is given by the level broadening of the optically prouced K = 0 exciton due to lattice scattering, so that it is proporional to T except at low temperatures. If the coupling is strong, r the exciton effective mass is large, or the temperature is very igh, the absorption band is expected to be of a Gaussian shape, and is proportional to $\sqrt{T}$. The mutual influence of adjacent absorpon bands is also discussed; it causes the asymmetry and repulsion f the components as temperature rises. If T is replaced by the ensity of lattice imperfections, the above statements are valid, ithout substantial modifications, as regards the dependence on the egree of imperfections. These conclusions are in qualitative greement with experimental data. Further, the comparison proides information on the strength of the exciton—lattice coupling and e energy-band structure of the exciton.

539.2

11609 EFFECT OF RESONANCE EXCITATION TRANSFER IN THE THEORY OF A LARGE RADIUS EXCITON.

.I.Rashba.

h. eksper. teor. Fiz., Vol. 36, No. 6, 1703-8 (June, 1959). In ussian. English translation in: Soviet Physics—JETP (New York), ol. 36(9), No. 6, 1213-16 (Dec., 1959).

A theory for large-radius excitons is proposed, which takes into ccount Coulomb as well as resonance interaction. A transition to ontinuum, made under certain assumptions, leads to an integrofferential equation that contains a nonrelativistic contact term.

539.2

11610 THE MEAN FREE PATH OF AN EXCITATION IN A POLAR CRYSTAL.

A.V.Tulub.

h. eksper. teor. Fiz., Vol. 36, No. 6, 1859-68 (June, 1959). In ussian. English translation in: Soviet Physics — JETP (New ork), Vol. 36(9), No. 6, 1325-30 (Dec., 1959).

Low's method (Abstr. 3453 of 1955) is used to evaluate in the intermediate coupling approximation the scattering amplitude for the scattering of a phonon by an exciton by expressing it in the form of a matrix element between exact eigenfunctions of the energy operator corresponding to the initial and final states of the exciton. The basic approximation consists in the use of Haken's functions for the exciton wave functions. Detailed calculations are carried out for the case of large quantum numbers and for the ground state of the exciton. It is shown that the mean free path remains finite also for the case where the effective masses of the electron and of the hole are the same.

539.2

11611 LONG-RANGE SPIN INTERACTION AND THE MEISSNER—OCHSENFELD EFFECT.

R.M.May and M.R.Schafroth.

Progr. theor. Phys., Vol. 19, No. 6, 646-52 (June, 1958).

Mikura (Abstr. 5008 of 1958) has suggested, from a perturbation calculation, that an electron gas exhibits the Meissner—Ochsenfeld effect if a special type of spin-dependent interaction between electrons, $ge^2\sigma_1.\sigma_2/r$, is assumed. Here it is shown that in fact such a system exhibits only a modified paramagnetism.

539.2

11612 SPIN—LATTICE RELAXATION OF SHALLOW DONOR STATES IN Ge AND Si THROUGH A DIRECT PHONON PROCESS.

H.Hasegawa.

Phys. Rev., Vol. 118, No. 6,1523-34 (June 15, 1960).

The many-valley character of the conduction band edge of germanium and silicon causes an anisotropy of the g shift and of the deformation potential for the conduction electrons. It is shown that the combination of these two effects provides a mechanism for spin—lattice relaxations of the donor spins in germanium and silicon that yields $1/T_s$ proportional to the temperature T and to the fourth power of the static magnetic field H. Using known data about the deformation potential constant, the g shift, the energy of the intervalley splitting, and the elastic constants, the magnitude of T_s is found to be approximately 2×10^{-3} sec for phosphorus donors in germanium, and 1×10^4 sec for phosphorus donors in silicon. These values refer to $T = 1.25^\circ K$, $H = 3000$ G with the field applied along the [111] axis. The mechanism fails to give a finite T_s for donors in silicon, when the field is applied along the [100] axis.

539.2

11613 g FACTOR AND DONOR SPIN—LATTICE RELAXATION FOR ELECTRONS IN GERMANIUM AND SILICON.

L.M.Roth.

Phys. Rev., Vol. 118, No. 6, 1534-40 (June 15, 1960).

The g factors of electrons in Ge and Si are calculated on the basis of the effective mass approximation. The results are consistent with experimental spin resonance data. The effect is predicted to be anisotropic, with $g_{\parallel}$ less than $g_{\perp}$. This anisotropy introduces a strong interaction between the electron spin and shear waves, for the singlet donor ground state. This interaction can account in order of magnitude for the observed spin—lattice time τ_s for donor electrons in Si at low temperatures, including both a one-phonon process and a two-phonon Raman-type process. The temperature and magnetic-field dependence for the two processes are predicted to be $\tau_s^{-1} \propto TH^4$ and $\tau_s^{-1} \propto T^7H^2$, respectively. The temperature dependence agrees with experiment; however there are discrepancies in the magnetic-field dependence. τ_s is predicted to be anisotropic.

539.2

11614 THEORY OF LATTICE—SPIN RELAXATION.

K.A.Valiev.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1743-9 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1242-7 (Dec., 1959).

A theoretical discussion is given of relaxation in systems containing two types of interacting spin with very different values of their lattice relaxation times. The correlation function method is applied to the fast relaxing spin variables of the system.

539.2 : 538.2

11615 SPIN-WAVE RESONANCE IN A FERROMAGNETIC METAL.

G.T.Rado and J.R.Weertman.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 315-33 (Oct., 1959).

The spin-wave resonance studied in this paper is a modified ferromagnetic resonance which is strongly influenced by the exchange interactions existing in the skin depth. Experimental observations of this resonance are reported, the underlying physical conditions are explained and a general "exchange boundary condition" is formulated and derived. A description is given of an experimental method for measuring both components of the complex equivalent permeability. Static measurements as well as resonance curves at 3 and 4 kMc/s are presented for monocrystalline and polycrystalline samples of a nickel—iron alloy having extremely low magnetocrystalline anisotropy. At room temperature the complete experimental resonance curves can be interpreted on the basis of the theory of Ament and Rado by using an effective exchange stiffness constant, A, of $(3.3 \pm 0.5) \times 10^{-6}$ erg/cm and a spectroscopic splitting factor, g, of 2.06 ± 0.01. The agreement between theory and experiment would be destroyed if a Landau—Lifshitz or Bloch damping term were included. Possible processes influencing the value of A are discussed. Experimental data taken at liquid-nitrogen temperature show an increase in the resonance line width and a decrease in the resonance field. Both effects are in qualitative but not quantitative agreement with the theory. A part of the discrepancy can be attributed to anomalous effects caused by the electronic mean free path.

539.2

11616 CYCLOTRON RESONANCE IN TIN.
M.S.Khaikin.
Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1473-6 (Nov., 1959).
In Russian.

Cyclotron resonance was observed in fields up to 3000 Oe at 2.4°K and 9.4 kMc/s. Some effective masses are given in the preliminary analysis. D.J.Huntley

Defect Properties

539.2

11617 EVIDENCE FROM MOIRÉ TWISTING FOR LATTICE IMPERFECTIONS. J.Demny.
Z. Naturforsch., Vol. 15a, No. 3, 194-9 (March, 1960). In German.

Thin crystals of gold grown over each other in screw-like fashion (spiral crystals) were observed using transmission electron microscopy and often show moiré patterns. These patterns give the possibility of indirect examination of the crystal lattice and its imperfections. Some characteristic variations of pattern are described which are attributable to single and multiple defects and to stacking faults. Some typical patterns were reproduced using optical models. From film records the movement of defects and the growth of stacking faults can be followed. J.W.Leech

539.2

11618 LIGHT-SCATTERING BY DISLOCATION NETWORKS IN SINGLE CRYSTALS OF POTASSIUM CHLORIDE.
O.Theimer, C.A.Plint and W.A.Sibley.
Ann. Phys. (New York), Vol. 9, No. 4, 475-98 (April, 1960).

The theory of light scattering by systems of linelike scattering units is presented in a form suitable for studying light scattering by dislocation networks in transparent solids. The theory is applied to light scattering by single crystals of Harshaw potassium chloride which was measured for different wavelengths and scattering angles and for different orientations of the crystal with respect to the direction of the incident light beam. It was found that the scattering system has fourfold axes of rotation parallel to the $\langle 100 \rangle$ directions of the crystal, and a partial Fourier analysis of the scattering power indicates that the scattering is mainly produced by networks of dislocations in the $\{100\}$ planes, the individual lines being mostly directed along the $\langle 100 \rangle$ directions of the crystal. The rods have a width of about 1000 A and are, most probably, not perfectly straight; the latter feature prevents an estimate of their length.

539.2

11619 STUDY OF QUARTZ IMPERFECTIONS BY LIGHT SCATTERING. L.Taurel and S.P.F.Humphreys-Owen.
Proc. Phys. Soc., Vol. 75, Pt 4, 473-88 (April 1, 1960).

Light scattered by natural crystalline quartz is studied as a function of temperature and wavelength, and of time after change of temperature. Anomalous scattered flux is found to be divisible into two distinct fractions. The first fraction is highly anisotropic and orientation-sensitive and is consistent with the existence of "needles" lying parallel to the c-axis. This fraction reacts to a different rate to change of temperature, depending on whether the temperature is raised or lowered. A semi-quantitative interpretation is given of terms of substituted impurity atoms which form atmospheres near edge dislocation lines lying parallel to the axis. On lowering the temperature there is a drift to the atmospheres, and on raising the temperature there is a (faster) diffusion away from both . A single diffusion coefficient of the order 10^{-20} cm^2 sec^{-1} is derived for both processes. The equilibrium temperature dependence allows an estimate of the mean binding energy of an impurity atom to the dislocation line to be made which agrees with prediction from the theory of Cottrell and Bilby. The second fractions is not readily explained in terms, directly, of defects, and it is tentatively suggested that defects are indirectly responsible through perturbation of the spectrum of lattice vibrations, leading to a modification of thermal scattering.

539.2

11620 DISLOCATION[S] IN ZINC CRYSTALS WITH ELONGATE CELL SUBSTRUCTURE. M.Boček and P.Kratochvíl.
Czech. J. Phys., Vol. 9, No. 3, 406-7 (1959).

Tiller's theory (Abstr. 9120 of 1958) is applied to elongated cell and the calculated dislocation density is compared with experimental results obtained with Zn containing Cd. The causes of the smaller observed densities is also discussed. J.E.Caffyn

539.2

11621 RADIATION LIMITED DISLOCATION MOTION IN CRYSTALS. R.Thomson.
J. appl. Phys., Vol. 31, No. 3, 617 (March, 1960).

A dislocation, in traversing a Peierls hill and valley structure, must be expected to radiate energy as it moves in a roller coaster fashion through a crystal. The present article studies the case where the dislocation moves with nearly zero average velocity and the external stress is smaller than the Peierls stress. The radiatio loss per atom length of line in moving from the bottom of one hill to the top of the next is computed and compared with the energy gained as it moves one atomic distance through the stress field. The energ radiated is found to be much larger than the energy gained for any crystal with a critical shear stress of the usual magnitude. In fact, the ratio of the energies approaches unity only when the stress becomes approximately the Peierls value. The observed critical shea stress at which dislocations become mobile seems, therefore, not due to the dynamic motion of the dislocation but the dislocations may be thermally activated through the lattice hill and valley structure.
A.C.Whiffi

539.2

11622 FORMATION OF CAVITIES ON DISLOCATIONS IN CRYSTALS OF NaCl AND KCl.
L.W.Barr and J.A.Morrison.
J. appl. Phys., Vol. 31, No. 3, 617-19 (March, 1960).

Crystals of NaCl and KCl were annealed in the presence of hydrogen and chlorine. Cavities were formed in the crystals which contained gas at greater than atmospheric pressure and etching showed that these cavities occurred on dislocations. Cleavage of some of the crystals showed that most of the cavities were associat with pyramidal etchpits indicative of dislocations. A small number had no etchpits, showing that the pyramid is not a consequence of th cavity itself, and it was concluded that, in these cases, the dislocation had become detached from the cavity. If the maximum depth of cavity is interpreted as the chlorine penetration, the diffusion coefficient thus obtained agrees well with values obtained in ancillary experiments. The technique might be used to study the distribution of impurities, the mode of penetration of chlorine and the nature of the necessary vacancy sources. A.C.Whiffi

539.

11623 ETCH PITS IN GALLIUM ARSENIDE.
J.L.Richards and A.J.Crocker.
J. appl. Phys., Vol. 31, No. 3, 611-12 (March, 1960).

The etching characteristics have been studied with a view to revealing edge dislocations on different crystal faces and etches have been developed which will reveal dislocations on the A face $\{111\}$, the B face $\{\bar{1}\bar{1}\bar{1}\}$ or both. Five plates. W.Bardsle

539.

11624 DISLOCATION ETCH PITS ON THE $\{111\}$ AND $\{\bar{1}\bar{1}\bar{1}\}$ SURFACES OF InSb. H.C.Gatos and M.C.Lavine.
J. appl. Phys., Vol. 31, No. 4, 743-4 (April, 1960).

Suitable etching techniques have been found for revealing dislocation etch pits on the $\{\bar{1}\bar{1}\bar{1}\}$ or B surfaces as well as the $\{111\}$ or A type surfaces by employing a preferential inhibitor (stearic acid) in an oxidizing etch. Two types of pit appear on the A face with suc an etch. Group IV atoms in InSb lead to the formation of etch pits on A and B surfaces under etching conditions which normally only give pits on the A surfaces. W.Bardsley

539.2

11625 STUDY OF LiF CRYSTALS BY THE ETCH METHOD.

A.A.Urusovskaia.

Kristallografiya, Vol. 3, No. 6, 726-32 (Nov.,-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 731-7 (Jan., 1960).

The effect of annealing and deformation on the distribution of dislocations in LiF crystals has been studied. The dislocations were revealed by selective etching (3% H_2O_2). The formation and displacement of dislocations under compression and bending has been observed. High mobility of screw dislocations compared with edge dislocations has been found. An indication has been obtained of the grouping of dislocations in adjacent slip planes in rows perpendicular to the slip planes.

539.2

11626 PILING-UP OF DISLOCATIONS BENEATH A SURFACE FILM.

A.R.C.Westwood and L.J.Demer.

Nature (London), Vol. 186, 146-7 (April 9, 1960).

Electron-micrographical evidence is obtained for pile-up of dislocations in lithium fluoride with a coating of magnesium oxide. A.R.Stokes

539.2

11627 MICROMOSAIC PATTERNS IN SINGLE CRYSTALS OF POTASSIUM CHLORIDE CONTAINING BARIUM CHLORIDE.

J.Ewles and J.B.Dawson.

Nature (London), Vol. 186, 381-2 (April 30, 1960).

Photomicrographs of crystals containing barium in proportion of Ba/K = 5×10^{-4} showed patterns which might be interpreted as voids. A fine line structure was also observed which could be either dislocations produced by the impurity or precipitated barium on internal surfaces. J.E.Caffyn

539.2

11628 VACANCY RELAXATION IN CUBIC CRYSTALS.

L.A.Girifalco and V.G.Weizer.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 260-4 (Feb., 1960).

The configuration of the atoms surrounding a vacancy in four face-centred cubic and three body-centred cubic metals has been computed, using a pairwise, central-force model in which the energy of interaction betweem two atoms was taken to have the form of a Morse function. Only radial relaxations were considered. The first and second nearest-neighbour relaxations for the face-centred systems were found to be: Pb (1.42 –0.43), Ni (2.14, –0.39), Cu (2.24, –0.40) and Ca (2.73, –0.41, expressed in percentages of normal distances. For the body-centred systems the relaxations out to the fourth nearest neighbours to the vacancy were: Fe (6.07, –2.12, +0.25, –), Ba (7.85, –2.70, 0.70, –0.33) and Na 10.80, –3.14, .43, –0.20). The positive signs indicate relaxation toward the acancy and the negative signs indicate relaxation away from the vacancy. The energies of relaxation (eV) are: Pb (0.162), Ni (0.626), Cu (0.560), Ca (0.400), Fe (1.410), Ba (0.950) and Na (0.172). An stimate of the ease of motion of the atoms surrounding a vacancy n sodium was made, and it was concluded that Nachtrieb's relaxaion concept is probably valid in sodium.

539.2

11629 SPONTANEOUS FORMATION OF COLOUR CENTRES IN IRRADIATED ALKALI HALIDE CRYSTALS AFTER ANNEALING.

A.A.Vorob'ev and B.V.Budylin.

Fiz. tverdogo Tela, Vol. 2, No. 4, 663-4 (April, 1960). In Russian.

The colour centres were obtained in crystals of NaCl, KCl, KBr nd KI irradiated in a nuclear reactor to a maximum integral dose f 3.10^{19} neutrons/cm^2, and annealed at temperatures between 200° nd 450°C. A method for the volume irradiation of opaque materials s suggested. R.F.S.Hearmon

539.2

11630 MICROWAVE STUDIES OF COLOR CENTERS IN BARIUM OXIDE.

.W.Carson, D.F.Holcomb and H.Rüchardt.

J. Phys. Chem. Solids, Vol. 12, No. 1, 66-73 (Dec., 1959).

Electron spin-resonance absorption measurements have been made at 9300 Mc/s on BaO crystals with excess barium. No spin esonance is observed which can be associated with the imperfection responsible for the optical absorption band at 2.0 eV. A resonance is observed in some crystals which can be identified as arising from an F-centre, i.e., a single electron trapped at an oxygen vacancy in the lattice. This resonance shows a strong central line at $g = 1.936 \pm 0.006$, and four satellite lines, spaced 68 G apart. This pattern is consistent with the assumption of an F-centre as the source. Since the F-centre is observed, but is not correlated with the 2.0 eV optical absorption, it is concluded that the centre responsible for the 2.0 eV band is probably an F-centre, i.e., two electrons trapped at the oxygen vacancy. Large nonresonant microwave losses are also observed in the coloured crystals. The present measurements are unable to distinguish between conduction in colloidal barium particles and electronic conduction in crystalline BaO itself as the source of the large losses.

539.2

11631 THE INFRARED SPECTRUM OF THE U-CENTRE.

G.Schaefer.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 233-44 (Feb., 1960). In German.

The infrared vibration absorption of a point imperfection in alkali halides, the U-centre, has been measured. The frequency ν corresponding to the absorption maximum depends upon the lattice spacing and, in a first approximation, is given by the equation $h\nu d^2 = \text{const}$. For the examined crystals the wavelength of the absorption maximum lies in the range between 17.75 μ(NaCl) and 27.65 μ(RbI). The absorption lines show a marked narrowing if the crystal is cooled from room temperature to 57° K. The half-width decreases to about one tenth and is then of the order of magnitude 10^{-3} eV. For KCl and KBr at low temperatures, an oscillator strength of about 0.5 could be determined.

539.2

11632 INFLUENCE OF F CENTERS ON THE LATTICE THERMAL CONDUCTIVITY IN LiF.

R.O.Pohl.

Phys. Rev., Vol. 118, No. 6, 1499-508 (June 15, 1960).

The influence of photochemically produced F-centres in LiF on the thermal conductivity is investigated, the density of the F-centres being determined optically. The F-centres decrease the thermal conductivity appreciably at low temperatures. Additive coloration of KCl has a similar effect. The experimental results are quite different from the results obtained in the case of the isotope effect in Ge. Callaway's theory for the lattice thermal conductivity in the presence of point defects cannot explain the present observations satisfactorily, although it is superior to Klemens'. Two explanations are proposed: (a) the F-centres are not randomly distributed (but the presence of clusters of F-centres can be excluded in the experiments); (b) the long-range strain field around the F-centre does not scatter like a point defect. In support of Callaway's theory, it is shown that his model can explain an experimental observation (first reported by Toxen) about the influence of point defects on the thermal conductivity.

539.2

11633 TEMPERATURE DEPENDENCE OF OPTICAL BLEACHING OF KCl CRYSTALS NEAR 0°C.

W.E.Bron and A.S.Nowick.

Phys. Rev., Vol. 119, No. 1, 114-21 (July 1, 1960).

Further insight has been sought into the mechanism of optical bleaching in the vicinity of room temperature by studying the temperature dependence of the bleaching curves for KCl crystals which had been initially irradiated with hard (filtered) X-rays. The absorptions at the maxima of the F, M, R_1, and R_2 bands were observed to change during illumination with F-light and to be strongly temperature dependent in the range of –30° to +10° C, whereas the absorption at the V_3 band was essentially unchanged. For comparison an analysis was made of the data of Petroff on the early growth of the M band during bleaching with F-light in additively coloured KCl crystals. In this case, a unique activation energy, ϵ, of 0.35 ± 0.05 eV and a number of defect jumps $N_j \cong 10^{10}$ are indicated by the data. It appears that the bleaching curves of the X-irradiated samples are composed of a temperature independent and a temperature dependent part. The temperature dependent part is probably the same as that responsible for bleaching in additively coloured crystals. The above results for ϵ and N_j suggest that the temperature dependent bleaching process results from the trapping of photoelectrons at vacancy clusters which are formed during bleaching through the migration of mobile defects, possibly vacancy pairs. This conclusion is supported by the observations by others that the α band is not observed during bleaching at room temperature.

539.2

11634 COAGULATION, OPTICAL ABSORPTION, AND PHOTOCONDUCTIVITY OF COLLOID CENTRES IN ALKALI HALIDES.

W.T.Doyle.

Proc. Phys. Soc., Vol. 75, Pt 5, 649-63 (May, 1960).

The effects of optical illumination and impurities on colloidal formation are studied in additively coloured KCl and in NaBr coloured by ultraviolet light. It is shown that at elevated temperatures additively coloured KCl behaves as an auto-sensitized photographic system. A theory of the colloid band is presented which takes account of ion core polarization and harmonic mean effective mass for arbitrary ellipsoidal particles. The colloid band is identified as a bounded plasma resonance, shifted into the visible region by the boundary conditions. Plasma frequencies computed from the positions of the colloid bands are in good agreement with other estimates. The spectral dependence of photoconductivity associated with the colloid band is related to the band structure of the host medium.

539.2

11635 THERMAL BLEACHING OF COLOR CENTRES IN KCl.

K.Thommen.

Z. Naturforsch., Vol. 15a, No. 4, 362-4 (April, 1960). In German.

F, M and V absorption bands were produced in a KCl crystal after irradiation with 50 MeV α-particles. After annealing for 15 hr at 200° C, the F-and M-bands disappeared, but some V-band absorption still occurred; further annealing for 13 hr at 300° C caused all absorption bands to disappear. A crystal irradiated with X-rays behaved in a similar way. It is concluded that electrons freed from F-centres and holes freed from V-centres recombine at electron traps. J.Franks

539.2

11636 COLOUR CENTRE ASSOCIATES IN ALKALI HALIDES.

H.Pick.

Z.Phys., Vol. 159, No. 1, 69-76 (1960). In German.

F-centres in alkali halide crystals associate at room temperature under the action of light. New models are proposed for these associates, and experimental evidence is discussed. J.Franks

539.2

11637 DIFFUSION IN METALS.

P.G.Shewmon and F.R.Winslow.

Industr. engng. Chem., Vol. 52, No. 4, 343-6 (April, 1960).

Review of recent literature (books, periodicals, conference procéedings and reports) on the following: pure metals; alloys; interstitials; solutions; interfaces. The bibliography (arranged under the foregoing headings) comprises 105 items.

539.2

11638 BOUNDARY AND VOLUME DIFFUSION.

M.A.Krishtal.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 565-71 (1959). In Russian.

Results on volume, grain boundary and dislocation diffusion in pure Ag and Fe and for Cr diffusing into Fe were collected from a variety of sources. Re-analysis of the results on the basis of (1) $D = Ae^{-Q_1/RT}$ and (2) $D = (\delta^2/Nh)Q_2\, e^{-Q_2/RT}$ (δ = interatomic spacing) gave the following results: for volume self-diffusion only, A is similar for Ag and Fe; Q_2 is a linear slowly varying function of temperature for all forms of diffusion; Q_2 extrapolated to 300° K agrees with Q_1 for volume diffusion and self-diffusion only.

A.F.Brown

539.2

11639 THE DIFFUSION OF SILVER IN CUPROUS OXIDE.

A.I.Andrievskii, A.V.Sandulova and M.I.Yurkevich.

Fiz. tverdogo Tela, Vol. 2, No. 4, 624-8 (April, 1960). In Russian.

The diffusion of silver in cuprous oxide is investigated using marked atoms of Ag^{110}. The temperature dependence of the diffusion coefficient is given by $D = k\exp(-Q/RT)$ and values of Q and K are determined for single crystal and polycrystalline cuprous oxide. With single crystals, a plot of log D against T^{-1} gives a single line; with polycrystalline material the graph consists of two straight lines intersecting at about T = 850° C. For single crystal material at all temperatures, and for polycrystalline material above 850° C, diffusion occurs through vacant copper positions in the lattice; for polycrystalline material below 850° C it occurs through the intercrystalline layers. R.F.S.Hearmon

539.2

11640 ANISOTROPIC DIFFUSION OF ZINC IN POLYCRYSTALLINE CUPROUS OXIDE.

A.V.Sandulova and Dzhan Eĕ-Tsin.

Fiz. tverdogo Tela, Vol. 2, No. 5, 874-7 (May, 1960). In Russian.

The effect of the microstructure on diffusion of Zn in polycrystalline Cu_2O obtained by direct oxidation of Cu, was studied by the radioactive tracer (Zn^{65}) technique. There was a marked difference between the rates of diffusion in the directions parallel to and perpendicular to the direction of the crystal growth; this difference decreased with rising temperature. The predominant mode of diffusion of 600-800° C was along the grain boundaries, but at 850-1050° C transcrystalline diffusion predominated. The anisotropy of diffusion of Zn in polycrystalline Cu_2O was attributed to the variation of the lattice parameter and differences in the topography of the grain boundaries and cohesion between the individual grains.

M.H.Sloboda

539.2

11641 SOME OBSERVATIONS REGARDING THE PRESENT STATUS OF MEASUREMENTS OF THE DIFFUSION COEFFICIENTS OF HYDROGEN IN IRON AND MILD STEEL.

R.C.Frank.

J. appl. Phys., Vol. 29, No. 8, 1262-3 (Aug., 1958).

539.2

11642 DIFFUSION OF PHOSPHORUS IN SILICON OXIDE FILM.

C.T.Sah, H.Sello and D.A.Tremere.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 288-98 (Oct., 1959).

The system P_2O_5 (vapour), SiO_2 (thin film) and single-crystal silicon has been investigated by solid-state-diffusion techniques. The p-type silicon underneath the silicon oxide film was used as a "phosphorus detector". A rapid and complete chemical reaction apparently takes place between the SiO_2 and the diffusant, phosphoru or phosphorus oxide, forming a glass (or compound) of unknown composition $P_xSi_yO_z$ at the glass/Si interface. A sharp boundary is found between the glass and unreacted SiO_2. The results indicate that the growth of the glass is limited by the diffusion of the phosphorus species in the glass with very little or no diffusant left to diffuse in the unreacted silicon dioxide after the complete reaction at the glass/silicon dioxide interface. The growth of this compound or glass follows the parabolic law and is experimentally given by $x_m^2/t_m = 1.7 \times 10^{-7} \exp(-1.46/kT_m)$ cm^2/sec over the temperature range 900-1250° C. Here x_m is the thickness of the glass, t_m the diffusion time and T_m the diffusion temperature (°K). The subscript m denotes the condition of complete masking of the silicon oxide against phosphorus, i.e. no n–p junction is formed. Diffusion experiments in which the silicon oxide film failed to mask or only partially masked against P_2O_5, i.e. x_0^2/t_d was smaller than the value given for x_m^2/t_m, where x_0 is the original oxide thickness and t_d is the diffusion time, were also performed and could be interpreted by using a two-boundary diffusion model. In this case, a species of phosphorus or phosphorus oxide apparently diffuses throu the glass with a diffusion coefficient, D_1, followed by the diffusion of phosphorus in the p-type silicon with a higher diffusion coefficient, D_2, to form a n–p junction underneath the glass. The segregation coefficient of phosphorus at the boundary between the glass and the silicon is apparently small. The transition region between complete masking and partial masking is well defined and occurs at a silicon oxide layer thickness < 500 A. Such a rapid change represents the transition between the models discussed above: the model for the growth law of the glass in silicon oxide and the two-boundary diffusion model for partial masking.

539.

11643 ANISOTROPIC DIFFUSION OF COPPER INTO BISMUT TELLURIDE.

R.O.Carlson.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 65-70 (May, 1960).

Bismuth telluride (Bi_2Te_3) has a layer structure (...TeBiTeBiTe–TeBiTeBiTe–Te ...) and readily cleaves perpendicular to the c-ax of the rhombohedral crystal. A marked difference has been found between the penetration of radioactive copper parallel to and perpe dicular to the cleavage planes in Bi_2Te_3. $D_{\parallel} = D_0 \exp-(E/kT = 0.00$ $\exp(-0.21\ eV/kT)$, $D_{\perp} = 0.071 \exp(-0.80\ eV/kT)$. At room temperature, $D_{\parallel} \sim 10^{-6}$ cm^2/sec, while extrapolated $D_{\perp}$ is more than eight decades lower at $\sim 3 \times 10^{-15}$ cm^2/sec. Minute cracks, except perhaps on an atomic scale, are not believed responsible for the fast parallel diffusion. The fast parallel diffusion can be rationalized o the basis that in this direction, between adjacent tellurium layers the copper moves through a region of relatively weak electrostatic onding forces and large layer spacing. In any other direction, co- alent and ionic bonding between tellurium and bismuth atoms would ake penetration more difficult. Zener's theory is shown to give a easonable fit to the D_0 values, requiring a negligible entropy term r parallel diffusion and a small entropy term, approximately the oltzmann factor k, for perpendicular diffusion.

539.2

11644 **A STUDY OF THE SELF-DIFFUSION OF URANIUM IN THE β-PHASE.** Y.Adda, A.Kirianenko and C.Mairy.
. nuclear Mater., Vol. 1, No. 3, 300-1 (Oct., 1959). In French.

The diffusion of U enriched in U^{234} into natural uranium was tudied at temperatures between 973^{0} and 1028°K (β-phase). The iffusion coefficient obeys the law $D = D_0 \exp(-Q/kT)$ with = 42 kcal/mole and $D_0 = 0.0135$ cm^2/sec. The activation energy thus considerably higher then in the γ-phase, probably due to the resence in the β-phase of a certain amount of covalent bonding.

L.Pincherle

539.2

11645 **THE DIFFUSION OF FISSION KRYPTON FROM METALLIC URANIUM.** M.B.Reynolds.
uclear Sci. Engng, Vol. 1, No. 5, 374-82 (Oct., 1956).

The rare gases have not been shown to exhibit measurable quilibrium solubility in metals, nor do any common metals exhibit easurable permeability to the rare gases. By means of nuclear eactions, however, "solid solutions" of rare gases in metals may be roduced which permit the rare gas diffusion process to be studied. esults of work on the system radio krypton—uranium are presented. iffusion of radiokrypton from small cylinders of irradiated normal anium was found to be negligible at temperatures below 100°C. he diffusion rate was found to be quite temperature-sensitive and as considerably enhanced by thermal cycling. Swelling of the metal ecimen during the diffusion process and the fact that the theoreti- l time dependence was never observed, leads to the conclusion that s escape is by way of grain boundaries or microcracks. A ssible mechanism to explain the thermal cycling behaviour is esented.

539.2

11646 **ACTIVATION ENERGY FOR THE SURFACE MIGRATION OF TUNGSTEN IN THE PRESENCE OF A HIGH-ELEC- RIC FIELD.** P.C.Bettler and F.M.Charbonnier.
hys. Rev., Vol. 119, No. 1, 85-93 (July 1, 1960).

An activation energy for the surface migration of tungsten oms on the tungsten crystal lattice structure and under the influ- ce of a high electric field was measured using field emission tech- ques. The initially hemispherical field emitter tip surface de- rms into a polyhedral shape in a process known as build-up, when e emitter is heated in the presence of large electrostatic forces. uild-up proceeds in a regular and reproducible manner; certain ages of build-up can be identified by characteristic changes in th the field emission patterns and the current versus time charac- ristics of the emitter. An activation energy of 2.44 ± 0.05 eV/atom as determined, from the measured values of the time required to hieve a given degree of build-up at various operating temperatures. his value may be compared with the value of 3.14 eV/atom deter- ined from the rate at which the tip of a heated tungsten emitter re- edes in the absence of an electric field. Explanations for the differ- ce are presented, involving two distinct factors: (a) a reduction in tivation energy, through the effect of polarization of the surface oms by the electrostatic field, by an amount which was determined a special experiment; and (b) an inherent difference which remains ter allowance has been made for the field effect. The latter is as- ibed to the difference in the paths of migration in the two cases ereby, for the conditions existing in this experiment, the activa- n energy measured is that corresponding to migration primarily er the low index (100), (110), and (211) planes. A value of 79 ± 0.08 eV/atom is obtained after correction for the field effect.

539.2

11647 **THE USE OF RADIOACTIVE INDICATORS IN SOLVING THE PROBLEM OF INTERNAL ADSORPTION IN LID BODIES.** V.I.Arkharov, S.M.Klotzman and A.N.Timofeev.
nuclear energy, Vol. 9, No. 1-4, 209-11 (June, 1959). English anslation from Atomnaya Energiya, Vol. 4, 380 (1958).

Preliminary autoradiographic investigations show that the dition of 0.4% Sb or 0.1% Be to copper substantially changes the te of grain boundary diffusion of Ag^{110} into copper. A general scussion of the application of radiotracers to the study of gregation of impurities in metals is given.

R.F.Peart

539.2

11648 **DISPLACEMENT OF THE SULFUR ATOM IN CdS BY ELECTRON BOMBARDMENT.** B.A.Kulp and R.H.Kelley.
J. appl. Phys., Vol. 31, No. 6, 1057-61 (June, 1960).

The threshold for displacement of the sulphur atom from a lattice point in CdS has been measured to be 8.7 eV. This is accomplished with 115 keV electrons. This is also the threshold for the production of green edge emission centres and of centres for a red fluorescence band with a maximum intensity at about 7200 A. In crystals which show edge emission before bombardment, the edge emission is removed by electron bombardment in the energy range 2.5 to 200 keV. The red luminescence is not removed by electron bombardment but increases in intensity with bombardment above the threshold. The radiation "annealing" of the edge emission is accomplished even in crystals which do not thermally anneal. A model is proposed with the sulphur interstitial atom the centre for edge emission, and the sulphur vacancy the centre for the red emission band.

539.2

11649 **STORED ENERGY IN NEUTRON-BOMBARDED GRAPHITE.** T.J.Neubert and R.B.Lees.
Nuclear Sci. Engng, Vol. 2, No. 6, 748-67 (Nov., 1957).

Fast neutron bombardment of graphite displaces carbon atoms to interstitial positions and produces lattice vacancies. Upon heating the interstitial disturbances become mobile, move to more stable positions and release stored energy. The thermal release of stored energy was investigated by relative specific heat measurements, which are described in detail. Data are presented which show the dependence of energy storage upon extent of neutron bombardment and upon temperature of bombardment. Activation energy spectra for the thermal release of stored energy are calculated. The general trends of the data are discussed. Estimates are made of the numbers of interstitial carbon atoms, interstitial carbon (C_2) molecules, and lattice vacancies in a sample of low bombardment. It is suggested that annealing of irradiated graphite causes much of the interstitial material to reintegrate with the graphite lattice by filling lattice vacancies.

539.2

11650 **MECHANISM OF DIMENSIONAL INSTABILITY OF URANIUM.** L.L.Seigle and A.J.Opinsky.
Nuclear Sci.Engng, Vol. 2, No. 1, 38-48 (Feb., 1957).

An explanation of the dimensional instability of alpha-uranium under irradiation is advanced, based upon the anisotropic diffusion of lattice imperfections to grain boundaries and free surfaces. An approximate solution of the diffusion equations for an ellipsoidal grain is obtained, which predicts growth rate as a function of pile flux, temperature, and grain size. The calculations are applied to polycrystalline material and some comparisons made between theory and experiment, which confirm the feasibility of the suggested mechanism of dimensional instability.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

539.2 : 537.3 : 621 385.1 : 621.315.612.6

11651 **THE EFFECTS OF LEACHING AND SILICONES ON THE SURFACE CONDUCTIVITIES OF SEALING GLASSES.**
J.Edge and L.F.Oldfield.
Glass Technol., Vol. 1, No. 2, 69-79 (April, 1960).

In a previous paper (Abstr. 11699 of 1959), the authors showed the necessity for removing a proportion of the alkali from the surface of a glass of high alkali oxide content before applying a silicone film to ensure resistance to atmospheric weathering. The durability of the silicone film in severe climatic conditions was tested using the surface conductivity of the glass at room temperature as a criterion. The present paper is concerned with the various factors which contribute to the measured values of this surface conductivity, for example the time of exposure to humidity, polarization due to continuous direct current, and the influence of leaching and baking procedures employed for the surface pretreatment. Four types of glasses were studied: a high alkali glass, a soda glass, a lead glass and a borosilicate glass. The initial conductivity of the untreated glass surfaces was dependent upon the alkali oxide content of the glass composition. The initial rate of change of conductivity with exposure time was also influenced by the alkali content in a similar manner Siliconed samples of these glasses were subjected to an accelerated climatic test at 55° C and 95% relative humidity. In all cases the breakdown of the silicone film was shown to be inevitable in these severe conditions, but a leach-bake procedure definitely improved the performace of the soda glass and gave a marginal improvement with the lead glass, but produced a deleterious effect with the borosilicate glass.

539.2 : 537.3

11652 THEORY OF ELECTRICAL CONDUCTION IN HIGH MAGNETIC FIELDS.

P.N.Argyres and L.M.Roth.
J. Phys. Chem. Solids, Vol. 12, No. 1, 89-96 (Dec., 1959).

It is pointed out that previous quantum-mechanical theories of transport in high magnetic fields are deficient in that they neglect the effect of the electric field on scattering. It is demonstrated here that in the case of large Hall angles, i.e. $\omega_0\tau \gg 1$, the transverse current can be obtained by a direct expansion in powers of the scattering potential. Both elastic and inelastic collisions are considered. It is found that the transverse current can be described in terms of the drift of the centres of cyclotron orbits of the electrons in the magnetic field. This justifies the original semi-classical method of calculation of Titeica. It is pointed out, however, that such a procedure is correct only for a non-oscillating electric field. No applications are made.

539.2 : 537.3

11653 THE QUANTUM ANALOGUE OF THE COLLISION INTEGRAL FOR ELECTRONS IN MAGNETIC AND ELECTRIC FIELDS.

A.M.Kosevich and V.V.Andreev.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 882-8 (March, 1960). In Russian.

The influence of an electric field on the quantum analogue of the collision integral for electrons in a metal in a magnetic field was investigated. For this purpose the quantum kinetic equation for electrons in a metal in crossed magnetic and electric fields was derived for low temperatures when electron scattering occurs mainly on impurities. It was found that the purely quantum term in the "collision integral", which is proportional to the electric field and was not taken into account in the kinetic equation by Lifshits (Abstr. 3063, 5930 of 1958), plays an important role in the quantum effects appearing in strong magnetic fields. Oscillations of the "transverse" electrical conductivity tensor elements on variation of the magnetic field were also considered.

539.2 : 537.3

11654 THE ELECTRICAL CONDUCTIVITY OF FLUORITE.

G.M.Zakharov, T.I.Nikitinskaya and A.G.Khapachev.
Fiz. tverdogo Tela, Vol. 1, No. 5, 835-7 (May, 1959). In Russian.

Reports measurements of the electrical conductivity σ of artificially grown CaF_2 crystals between 150° and 650° C in an atmosphere of argon or helium. The conductivity was measured during unidirectional pulses of 1 kV amplitude, 0.5 μsec duration and 1 kc/s repetition frequency. A linear dependence of log σ on 1/T was obtained (T is the absolute temperature); the activation energy deduced from the slope was 16 000 cal/mole. A.Tybulewicz

539.2 : 537.3

11655 ELECTRICAL CONDUCTION IN KERATIN.

J.E.Algie, J.G.Downes and B.H.Mackay.
Textile res. J., Vol. 30, No. 6, 432-4 (June, 1960).

The increase in electrical conductivity of keratin fibers after the application of an abrupt change of the relative humidity from 0 to 90% R.H. was examined as a function of time. A comparison of these results with regain vs. time, for the same experimental conditions, indicates that the water inside a fiber is not initially in a state which facilitates conduction. It is proposed that the slow rise of conductivity is due to the formation of a hydrogen bonded network which allows the passage of protons under the influence of the applied electric field.

539.2 : 537.3

11656 A CONTRIBUTION TO THE STUDY OF THE ELECTRICAL CONDUCTIVITY OF NON-STOICHIOMETRIC MANGANESE FERRITES.

K.Závěta.
Czech. J. Phys., Vol. 9, No. 6, 748-9 (1959).

The resistivity ρ of samples of various compositions was measured at temperatures T between −50° and 300° C. The curves of log ρ against 1/T showed a change of slope near 44° C, but not at the Curie temperature. The activation energies are higher when the composition is not stoichiometric, probably due to the manganese ions. R.C.Kell

539.2 : 537.3

11657 SOME PHYSICAL PROPERTIES OF NEPTUNIUM METAL. III. THE ELECTRICAL RESISTIVITY AND THERMOELECTRIC POWER OF NEPTUNIUM METAL IN THE RANGE 300-900° K.

J.A.Lee, J.P.Evans, R.O.A.Hall and E.King.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 278-83 (Oct., 1959).

For Pt II, see Abstr. 12056 of 1960. The electrical resistance of a sample of neptunium metal has been measured between 300 and 900° K, and the resistivity of neptunium in its three allotropic modifications calculated. A measurement of the thermal e.m.f. of a neptunium—platinum thermocouple has been made within the temperature-stable range of each allotrope, and the corresponding absolute thermoelectric powers calculated. The results are discussed briefly.

539.2 : 537.3

11658 ELECTRICAL CONDUCTIVITY OF X-IRRADIATED KCl.

R.W.Christy and E.Fukushima.
Phys. Rev., Vol. 118, No. 5, 1222-5 (June 1, 1960).

The conductivity of Harshaw KCl crystals was measured isothermally as a function of time in the temperature range 150-200° C, after exposing the crystals at room temperature to X-ray doses sufficient to produce about 10^{16} F-centres/cm^2. Besides the F-band, a V-band at about 5.75 eV is produced. If the F-band is eliminated by optical bleaching before the measurement but the V-band remains, the conductivity increases monotonically to an asymptotic value, which is equal to the conductivity of the unirradiated crystal for virgin samples but is lower for samples which have been annealed in air at 260° C beforehand. If both the F-band and the V-band are present, the conductivity increases more rapidly at first, and then decreases to an asymptotic value. The behaviour is qualitatively similar to that previously observed in NaCl, though there are significant differences in the optical absorption spectrum and temperature dependence of the conductivity changes.

539.2 : 537.3

11659 THE ELECTRICAL CONDUCTIVITY OF SODIUM ALUMINIUM SILICATE GLASSES.

V.A.Ioffe and G.I.Khvostenko.
Fiz. tverdogo Tela., Vol. 2, No. 3, 509-16 (March, 1960). In Russian.

The electrical conductivity of the glass system $Na_2O.x\,Al_2O_3.(y-x)SiO_2$ was investigated for various values of x and y in the temperature range from 15° to 240° C. The conductivity depends on the ratio of the atomic content of aluminium to silicon in the glass. For an increase in Al/Si, the conductivity increases and the activation energy decreases. Assuming that the conductivity of the glasses is a combination of ionic and electron, then an increase in the ratio Al/Si increases the contribution of the electron conductivity and decreases the ionic contribution. K.N.R.Taylor

539.2 : 537.3

11660 RESISTIVITY OF VACUUM-DEPOSITED BISMUTH.

M.N.Markov and I.S.Lindstrem.
Fiz. tverdogo Tela, Vol. 1, No. 5, 827-8 (May, 1959). In Russian.

Layers of 99.999% pure bismuth were prepared by evaporation in 10^{-5} mm Hg vacuo at the rate of 2-3 A/sec. The electrical resistivity of 0.1-1.0 μ thick layers was independent of their thickness and was about 4 times greater than the resistivity of the bulk material. Below ~ 0.1 μ, the resistivity rose sharply with decrease of thickness. When the rate of evaporation was increased by a factor of 10, the thickness-independent resistivity rose by a factor of 1.7. The resistivity was independent of the nature of the substrate the results were the same for glass, nitrocellulose and rocksalt substrates. A.Tybulewicz

539.2 : 537.3

11661 INVESTIGATION OF GALVANOMAGNETIC PHENOMEN IN CHROMIUM AT LOW TEMPERATURES.

E.S.Borovik and V.G.Volotskaya.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1650-5 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1175-8 (Dec., 1959).

The Hall effect and magnetoresistance were studied in the temperature range 4.2-78° K for fields up to 27 000 Oe. The electro concentrations and mobilities have been calculated from the data obtained. A preliminary investigation of the properties of Zr was carried out.

539.2 : 537.3

11662 ON THE MAXIMUM OF THE ELECTRIC RESISTANCE OF FERROMAGNETICS AT THEIR CURIE POINTS AT LOW TEMPERATURES.

E.I.Kondorskii, O.S.Galkina and L.A.Chernikova.

Zh. eksper. teor. Fiz., Vol. 38, No. 2, 646-8 (Feb., 1960). In Russian.

Experimental tests were made at temperatures below 20°K to check the predicted existence of maxima of the resistivity of ferromagnetics at their very low Curie points. The test specimens were Cu—Ni alloys containing 58.00% and 59.25% of copper. The results are exhibited in four graphs with resistivities as ordinates and temperatures as abscissae, and in each case the specimen is located in a constant magnetic field. All show maxima of resistivity, the most marked being that for the alloy with 59.25% Cu in zero field. The theoretical predictions made for semiconductors appear to apply to ferromagnetic metals also. See Abstracts 7902, 8442 and 3758 of 1958. N.Davy

539.2 : 537.3

11663 VARIATION OF THE RESISTANCE OF METALS IN HIGH MAGNETIC FIELDS. B.Lüthi.

Helv. phys. Acta, Vol. 33, No. 2, 161-82 (1960). In German.

Measurements of the transverse and of the longitudinal magnetoresistance of polycrystalline metals in pulsed magnetic fields up to 220 kG are reported. The residual resistances of the different specimens vary between 1% and 0.01%. In the logitudinal case all the metals investigated, except Li and Fe, show a well pronounced saturation in high fields. In the transverse case, only Al and In show saturation behaviour, Cu, Ag and Au follow exactly a linear law, while the other metals (Zn, Sn, Pb, Fe, Ni and Pt) have a magnetic field dependence which lies between a linear and a quadratic law. A detailed comparison with existing theories (Lifshits et al.) is made and it is found that the results can be understood at least in a qualitative way by making use of the concept of open orbits.

539.2 : 537.3

11664 RESISTIVITY CHANGES IN FERRITES IN A MAGNETIC FIELD. H.Schröder.

Naturwissenshaften, Vol. 47, No. 8, 175-6 (1960). In German.

The transverse magneto-resistance coefficient of nickel ferrite drops rapidly with rising temperature and becomes too small to be detected above 350°C. There is no resistivity anomaly at the Curie point; this is in marked contrast with measurements on manganese ferrite reported by Belov (Abstr. 5743 of 1959). R.Parker

539.2 : 537.3

11665 ELECTRICAL AND MAGNETORESISTANCE PROPERTIES OF SINGLE CRYSTALS OF MANGANESE FERRITE. K.P.Belov, A.A.Popova and E.V.Talalaeva.

Kristallografiya, Vol. 3, No. 6, 733-9 (Nov.-Dec., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 738-43 (Jan., 1960).

The temperature-dependence of the electrical resistance and longitudinal magnetoresistance were measured. The temperature-dependence of the resistance is complex: close to the Curie point, on the straight lines log ρ (1/T), "step" discontinuities are observed. The supposition is made that these "steps" are formed because the crystals pass, at the Curie point, into a certain degenerate electronic state. It was found that the dependence of the longitudinal magnetoresistance on temperature, on field and on magnetization, is similar to the dependence observed for metallic ferromagnetic materials.

539.2 : 537.3 : 538.2

11666 TRANSVERSE EFFECTS IN IRON—SILICON SINGLE CRYSTALS. H.E.Schmidt and T.Halpern.

Z. Naturforsch., Vol. 15a, No. 2, 149-55 (Feb., 1960). In German.

Electrical resistance, thermoelectric force and the four galvano- and thermomagnetic transverse effects (Hall coefficient, Ettinghausen coefficient, Ettinghausen—Nernst coefficient, and Righi—Leduc coefficient) were measured at two different orientations on Fe—Si single crystals, taken from recrystallized transformer sheet (containing 4.36% Si), to determine the dependence of the effects on the orientation, and to test facets of the theory of ferromagnetic transverse effects. G.C.Williams

539.2 : 537.311 : 534.23

11667 RESONANCE ABSORPTION OF HIGH-FREQUENCY SOUND ENERGY BY SEMICONDUCTOR CURRENT CARRIERS IN A MAGNETIC FIELD. E.P.Pokatilov.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1153-9 (April, 1960). In Russian.

The absorption coefficient of ultrasound in a semiconductor is estimated with allowance for quantization of the electron energy in a magnetic field.

539.2 : 537.3 : 536.2

ELECTRICAL PROPERTIES OF Be, Mo AND W.

See Abstr.11588

539.2 : 537.3 : 538.2

ELECTRICAL PROPERTIES OF DILUTE Cu ALLOYS.

See Abstr. 10092

Semiconductors

539.2 : 537.311

11668 CALCULATION OF THE REFRACTIVE INDEX NEAR THE FUNDAMENTAL ABSORPTION EDGE OF ELEMENTAL SEMICONDUCTORS. L.I.Korovin.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1311-16 (Aug., 1959). In Russian.

Considers dispersion of permittivity in the region of the fundamental absorption edge, this dispersion being due to direct transitions of electrons from the valence to the conduction band. The simplest variant of the effective-mass method and the dipole approximation are used. Formulae are obtained which give the frequency dependences of the real and imaginary parts of permittivity and the refractive index. The theory agrees qualitatively with experiment in the case of germanium and silicon. A.Tybulewicz

539.2 : 537.311

11669 SEVERAL NEW METHODS TO MEASURE THE THERMAL DIFFUSIVITY OF SEMICONDUCTORS.

J.H.Becker.

J. appl. Phys., Vol. 31, No. 3, 612-13 (March, 1960).

Discusses some methods applicable to small samples. One surface is heated at a time varying rate (not necessarily sinusoidally) and for some cases also steadily. The temperature changes are deduced from various thermal-electrical effects, such as the variation of electrical conductivity with temperature, the Nernst and Seebeck effects. The diffusivity can be derived from various combinations of the appropriate a.c. and d.c. voltages. R.Berman

539.2 : 537.311

11670 A THEORY OF IMPURITY CONDUCTION. II.

T.Kasuya and S.Koide.

J. Phys. Soc. Japan, Vol. 13, No. 11, 1287-97 (Nov., 1958).

For Pt I, see Abstr. 12239 of 1959. Impurity band conduction is treated for the case in which the resonance energy (or the translational energy) is much smaller than the fluctuation of local potential energy. By interaction with a phonon, an electron can jump from one localized state to another, exchanging the difference of the local potential energies for a phonon. Agreement between theoretical and experimental results is fairly satisfactory.

539.2 : 537.311

11671 INTEGRAL EQUATIONS FOR THE DETERMINATION OF THE MOBILITY IN SEMICONDUCTORS. W.Franz.

Z. Naturforsch., Vol. 15a, No. 4, 366-8 (April, 1960). In German.

Starting with the Boltzmann equation, an iterative method is formulated for the calculation of the mobility tensor of hot electrons. It is claimed that this proceedure converges in a few steps. P.T.Landsberg

539.2 : 537.311 : 537.56

THE INFLUENCE OF COLLISIONS BETWEEN ELECTRONS ON THEIR VELOCITY DISTRIBUTION IN SEMICONDUCTORS.

See Abstr. 10903

539.2 : 537.311

11672 THEORY OF IMPACT RECOMBINATION IN SEMICONDUCTORS. V.A.Bonch-Bruevich and Yu.V.Gulyaev.

Fiz. tverdogo Tela, Vol. 2, No. 3, 465-73 (March, 1960). In Russian.

Reviews previous calculations of impact recombination cross-sections at deep traps. Account is taken of the interaction between current carriers and estimates are made of the exchange term in the capture of minority carriers and the effect of Coulomb forces in the capture by charged centres. The sign of the charge is not important and the Coulomb field decreases the recombination coefficient by a factor of 1.5 - 2 (which is, in any case, within the limits of accuracy of the calculation). R.Berman

539.2 : 537.311

11673 THE STATISTICAL THEORY OF THE ELECTRICAL CONDUCTIVITY OF SEMICONDUCTORS. III.

M.I.Klinger.

Fiz. tverdogo Tela, Vol. 1, No. 9, 1384-92 (Sept., 1959). In Russian.

For Pt II, see Abstr. 8561 of 1960. Discusses the electrical conductivity of an impurity semiconductor and a new effect due to transitions of electrons from the conduction band to the impurity levels (de-ionization), and conversely (ionization), and due to elastic collisions of electrons with phonons. The contribution of this effect in ionic semiconductors is estimated. A.Tybulewicz

539.2 : 537.311

11674 THERMALLY STIMULATED CONDUCTIVITY IN SEMICONDUCTORS.

I.I.Boiko, É.I.Rashba and A.P.Trofimenko.

Fiz. tverdogo Tela, Vol. 2, No. 1, 109-17 (Jan., 1960). In Russian.

Using a fairly general model of a semiconductor, a theory of the thermally stimulated electrical conductivity is constructed. It is shown that the depth of local levels can be deduced from the thermally stimulated conductivity curves obtained at various rates of heating. A preliminary comparison of the theory with experimental results is given for CdS crystals. A.Tybulewicz

539.2 : 537.311

11675 THE CURRENT—VOLTAGE CHARACTERISTIC OF AN n—p JUNCTION CALCULATED WITH ALLOWANCE FOR THE GENERATION AND RECOMBINATION OF CURRENT CARRIERS IN THE SPACE-CHARGE LAYER. A.D.Chevўchelov.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1205-12 (Aug., 1959). In Russian.

Sah, Noyce and Shockley's theory (Abstr. 178 of 1958) of the generation and recombination of carriers in the transition layer of a p—n junction is criticized. A strict calculation is reported which gives the current—voltage characteristic, with allowance for the generation and recombination when $d/L \sim 1$ (d is the half-width of the transition layer and L is the carrier diffusion length).
A.Tybulewicz

539.2 : 537.311 : 621.382

11676 INTERVALLEY NOISE.

P.J.Price.

J. appl. Phys., Vol. 31, No. 6, 949-53 (June, 1960).

A theory is developed for the spectrum of electrical noise due to electron transitions between several quasi-isolated groups of states, in the general case where each group may carry part of an electric current. It is applied to the noise due to transitions between valleys of the conduction band of germanium, and the possibility of observing this noise is discussed using the data of Weinreich, Sanders and White on the frequency of intervalley transitions (see Abstr. 6969 of 1959).

539.2 : 537.311 : 621.382

11677 CONTRIBUTION TO THE KNOWLEDGE OF ION MOVEMENT IN SEMICONDUCTORS. F.Ollendorff.

Arch. Elektrotech. (Berlin), Vol. 45, No. 1, 10-26 (1960). In German.

An attempt is made to describe the movement of an ion in a homogeneous and isotropic semiconductor on the basis of a braking force set up by a tail of anti-polar carriers. A mathematical treatment of the effect of this force on the current density and potential of the semiconductor is given. G.C.Williams

539.2 : 537.311 : 621.382.333

11678 ON THE NEUTRON BOMBARDMENT REDUCTION OF TRANSISTOR CURRENT GAIN.

J.W.Easley and J.A.Dooley.

J. appl. Phys., Vol. 31, No. 6, 1024-8 (June, 1960).

Detailed measurements of the fast-neutron and gamma-ray bombardment behaviour of germanium-alloy-transistor current-gain were obtained concurrent with exposure. These data indicate that previously reported analyses, which lead to a linear dependence of common-base current-gain on fast neutron exposure, yield a good approximation for the n—p—n device, but are not of general validity for the p—n—p germanium transistor. The extent of departure from the linear approximation depends on the width and conductivity of the base-region and can be appreciable in many cases of practical interest. For the p—n—p germanium transistor it is necessary to take additional account of both changes during bombardment of the minority-carrier recombination rate at bombardment-introduced and initially present recombination centres and changes in the width of the collector junction depletion layer. Observed bombardment curves are in good agreement with an analysis which includes these effects. From initial slopes of the current-gain bombardment curves, values of the product of fast-neutron-exposure times minority carrier-lifetime at bombardment-introduced recombination centres are 9.7×10^7 for 2.7 ohm cm p-type and 14.2×10^7, 6.0×10^7, and 1.3×10^7, for 3.6 ohm cm, 1.2 ohm cm and 0.2 ohm cm n-type germanium, respectively, in units of sec neutrons/cm^2.

539.2 : 537.311 : 621.382.333

11679 MINORITY CARRIER RECOMBINATION IN A CYLINDRICAL TRANSISTOR BASE REGION. D.P.Kennedy.

J. appl. Phys., Vol. 31, No. 6, 954-6 (June, 1960).

An analysis is given on the influence of bulk recombination within the base region of a mesa A-type drift transistor. The minority carrier transport efficiency is established for a solid cylinder base region and also for a simplified one-dimensional structure. A comparison of the two minority carrier transport equations shows the approximate analysis will result in a negligible error when applied to practical semiconductor devices.

539.2 : 537.311 : 621.382

11680 THREE-ELEMENT SEMICONDUCTOR MATERIALS.

J.H.Wernick and R.Wolfe.

Electronics, Vol. 33, No. 7, 103-8 (Feb. 12, 1960).

Largely an elementary discussion of ways of predicting semiconductivity in compounds (see also Abstr. 5314 of 1957; 8100 of 1959; 13776 of 1959) and of the kinds of measurement made on new compounds to elucidate their semiconductor characteristics. $AgSbTe_2$ is discussed by way of illustration [see also Abstr. 5880 of 1958 and Geller and Wernick, Acta Cryst., Vol. 12, Pt 1, 46-54 (1959)]. It is noted that some specimens were apparently p-type from thermoelectric power (α) but n-type from Hall voltage (v); this anomaly was eventually traced to the presence of traces of silver telluride at grain boundaries. C.H.L.Goodman

539.2 : 537.311 : 531.75 : 533.5

11681 STUDIES OF SEMICONDUCTOR MATERIALS USING A VACUUM MICROBALANCE. S.P.Wolsky.

Semiconductor Prod., Vol. 2, No. 6, 36-41 (June, 1959).

In order to make reliable semiconductor devices, it is necessary to obtain information concerning the basic properties of the semiconductor materials. A very sensitive quartz microbalance housed in an ultra-high vacuum system is used in the investigation of germanium and silicon. A detailed description is presented of the microbalance, its associated apparatus, and the general experimental technique. Studies of sputtering, oxidation, and surface regeneration phenomena, as well as other applications of the microbalance, are discussed.

539.2 : 537.311

11682 PREDICTION RULES FOR THE SEMICONDUCTIVITY OF THE INORGANIC CRYSTAL LATTICES. J.P.Suchet.

J. Phys. Chem. Solids, Vol. 12, No. 1, 74-88 (Dec., 1959). In French.

Study of the exact significance of the "8-N" fule, wellknown to chemists and metallurgists, shows that the rule proposed by Mooser and Pearson for compound semiconductors must be supplemented by two analogous rules for 3- and 2-coordinated lattices. Purely covalent formulae are preferable to ionic ones for visualizing such electronic rules, and bonding schemes using them are capable of including defect lattices by treating the vacant sites as atoms of zero valency. A new concept of a "compensated lattice" is introduce based upon the knowledge of interactions between substitutional and interstitial impurities in germanium and silicon, and is applied to the study of compounds such as Li_3Bi which do not satisfy the bonding schemes mentioned above. The Bi_2Te_3-type structure is discussed in detail, and a classification of all known inorganic semiconductors in a few fundamental lattice types is proposed.

539.2 : 537.311

11683 SURFACE-DEPENDENT 1/f NOISE IN GERMANIUM.

A.U.Mac Rae and H.Levinstein.

Phys. Rev., Vol. 119, No. 1, 62-9 (July 1, 1960).

The surface characteristics of 1/f noise were investigated by sing field effect techniques on 100 μ thick single-crystal germanium filaments. The 1/f noise is independent of the surface potential when an accumulation layer is on the surface but increases rapidly s the surface conductivity gradually becomes inverted with respect o the bulk. No 1/f noise is observed due to charge transfer between he bulk and the slow surface states. An increase in the 1/f noise ssociated with the inversion layer occurs when the temperature of he germanium is decreased. The magnitude of the 1/f noise epends on the ambient, increasing as the slow state relation time ecreases. An investigation of the relaxation processes associated with the charge transfer between the bulk and the slow surface states fter the application of a d.c. electric field to the field effect elec-rode reveals a 1/f noise relaxation which is independent of the mode f the conductivity relaxation. The noise relaxes back to its original alue with a logarithmic time dependence which is characteristic of 1/τ distribution in time constants and the conductance decays with combination of exponential and logarithmic terms, depending on the urface conditions.

539.2 : 537.311

11684 NOISE MEASUREMENT IN GERMANIUM SINGLE CRYSTALS IN THE REGION OF THE COLLISION ONIZATION EFFECT BETWEEN 5° AND 10°K.

.Lautz and M.Pilkuhn.

aturwissenschaffen, Vol. 47, No. 9, 198 (1960). In German.

Using a low noise-level, selective amplifier arrangement, the oise current and electrical resistance of p-type and n-type Ge rystals were measured as a function of field strength. At low field trengths the crystals exhibited pure recombination noise in most ases, but at higher fields, which led to ionization by collision, the rop in resistance gave rise to a considerable increase in noise urrent. G.C.Williams

539.2 : 537.311

11685 THE RELATIONSHIP BETWEEN THE EXCESS NOISE AND THE SURFACE TRAPS IN GERMANIUM.

.S.Sochava and D.N.Mirlin.

iz. tverdogo Tela, Vol. 2, No. 1, 23-5 (Jan., 1960). In Russian.

Comparison of the frequency dependence of the field effect (be-veen 0.01 and 10^4 c/s) with the "excess noise" spectrum (between .5 and 10^4 c/s) of 20 ohm cm n-type germanium, subjected to various rface treatments, showed that they are different, contradicting IcWhorter's theory (Abstr. 7092 of 1957). A.Tybulewicz

539.2 : 537.311 : 621.382.333

11686 CONDITIONS FOR OBTAINING GERMANIUM TRANSISTORS BY DOUBLE DIFFUSION.

R.Deschamps.

. R. Acad. Sci. (Paris), Vol. 250, No. 19, 3137-9 (May 9, 1960). French.

It is shown that a transistor structure may be formed by dif-sion of an acceptor impurity followed by diffusion of a donor. A imple analysis is given which predicts the parameters of the two nctions. C.Hilsum

539.2 : 537.311

11687 EFFECTS OF ELECTRON BOMBARDMENT ON GERMANIUM. I. CHANGES IN CONDUCTIVITY.

.Huzimura and Y.Ato.

ep. Govt Industr. Res. Inst. (Nagoya), Vol. 9, No. 4, 185-91 April, 1960). In Japanese.

The effects of 1 MeV electron bombardment on conductivity of bout 10 ohm cm n-type, 1.8 ohm cm p-type, and 40 ohm cm undoped ain germanium single crystals were studied. The observed initial arrier removal rates were 0.12 cm^{-1} for n-type Ge and 0.43 cm^{-1} r p-type Ge. For undoped-Ge, the increment of carriers was bserved. If this increment is due to holes, the rate was 0.0045 cm^{-1} nd agreed with the rate of the introduction of holes in n-type ample. The number of the displaced atoms was calculated by the se of the model of Seitz and Koehler, and the energy level scheme f the radiation induced defects was estimated. The levels consist f a electron trap, 0.11 eV below the conduction band; a hole trap .10 eV above the valence band; and an acceptor level, 0.29 eV ove the valence band. Some suggestions on the bombardment chniques are also included in this report.

539.2 : 537.311

11688 HOT ELECTRON IN N-TYPE GERMANIUM.

J.Yamashita and K.Inoue.

Phys. Chem. Solids, Vol. 12, No. 1, 1-21 (Dec., 1959).

The non-ohmic current in a many-valley semiconductor has been investigated by considering scattering by acoustic and optical modes of vibration and intervalley scatterings. The intensity of these interactions has been determined from observed data for the temperature-dependence of the ohmic current, and the acousto-electric effect. The theoretical result for the drift velocity is in good quantitative agreement with the observations of Gunn and of Ryder over a wide range of the applied field. The anisotropy in the hot-electron current observed by Sasaki et al. is also discussed.

539.2 : 537.311

11689 EFFECT OF HIGH PRESSURE ON SOME HOT ELECTRON PHENOMENA IN n-TYPE GERMANIUM.

S.H.Koenig, M.I.Nathan, W.Paul and A.C.Smith.

Phys. Rev., Vol. 118, No. 5, 1217-21 (June 1, 1960).

The pressure dependence of the current density versus electric field characteristic for n-type germanium at 297°K was measured to a maximum pressure of 30 000 kg/cm^2, and to a maximum field of 10 000 V/cm. It is concluded that the electrons are "heated" by the field sufficiently to cause the conduction band valleys along the $\langle 100 \rangle$ directions in reduced momentum space to be appreciably populated with electrons at atmospheric pressure. The pressure dependence of the angle ϵ between current and field at 77°K was measured to a maximum field of 3000 V/cm and a maximum pressure of 5000 kg/cm^2. ϵ is independent of pressure except for a small increase for applied fields of ~3000 V/cm. Suggested interpretations for the data are given.

539.2 : 537.311

11690 THE NATURE OF THE VOLUME-GRADIENT E.M.F. DEVELOPED IN GERMANIUM IN THE PRESENCE OF A CURRENT.

P.I.Baranskii.

Fiz. tverdogo Tela, Vol. 2, No. 3, 463-4 (March, 1960). In Russian.

The volume-gradient e.m.f. in n-type germanium has been found to obey an empirical relation of the form $E_p = A(\exp\alpha I - 1)$, where A and α are constants and I is the current. The origin of the effect is associated with the injection of carriers in the germanium arising from a gradient of the specific resistance. K.N.R.Taylor

539.2 : 537.311

11691 THE CROSS-SECTION OF CAPTURE OF ELECTRONS AND HOLES BY ATOMS OF NICKEL IN GERMANIUM.

C.G.Kalashnikov and K.P.Tissen.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1754-7 (Nov., 1959). In Russian.

Deals with recombination at atoms of nickel in n-type phosphorus-alloyed germanium and reports measurements of the absolute capture cross-sections of nickel atoms for holes and electrons. A.Tybulewicz

539.2 : 537.311

11692 PROPERTIES OF OXYGEN IN GERMANIUM.

J.Bloem, C.Haas and P.Penning.

J. Phys. Chem. Solids, Vol. 12, No. 1, 22-7 (Dec., 1959).

Germanium crystals were zone-levelled in an oxygen atmosphere. The oxygen concentration in the crystal, as deduced from infrared absorption at 856 cm^{-1}, is proportional to the oxygen pressure $p(O_2)$ for $p(O_2) < 20$ mm Hg; at higher oxygen pressures, the oxygen concentration is constant at 7×10^{17} atoms/cm^3. On heat treatment at a relatively low temperature (400° C), donors are introduced in the crystal; the donors disappear again if the crystal is heated to a higher temperature (700° C). The number of donors depends strongly on the oxygen concentration. A tentative description of the results is given in terms of the equilibrium between isolated oxygen atoms and donor complexes consisting of four oxygen atoms. The Hall effect of the oxygen donors indicates the presence of several donor levels. In germanium crystals levelled under oxygen, two additional absorption bands were found at 1100 and 1260 cm^{-1}.

539.2 : 537.311

11693 VAPOR-DEPOSITED SINGLE-CRYSTAL GERMANIUM.

R.P Ruth, J.C.Marinace and W.C.Dunlap,Jr.

J. appl. Phys., Vol. 31, No. 6, 995—1006 (June, 1960).

Germanium layers have been formed on single-crystal Ge substrates by the thermal decomposition of GeI_2. The single-crystal nature of the layers has been established by X-ray and electron diffraction examination and by electrical measurements. The deposition process is described briefly. The crystal growth rate varies with crystal direction, and under certain conditions Ge whiskers appear. The layers as deposited are generally n-type; ρ ranges from 1 to 5 ohm cm and μ_H from 1200 to 2700 cm^2/V sec at room temperature. A donor level is found approximately 0.2 eV below the conduction band, with a concentration of active centres of about $10^{16}/\mathrm{cm}^3$. Heat treatment at 550° C gradually converts the layers to p-type, for which ρ is 10 to 40 ohm cm and μ_H 1500 to 2400 cm^2/V sec at room temperature; an acceptor level is found at about 0.05 eV above the valence band, with a density of active centres of 10^{14} to $10^{15}/\mathrm{cm}^3$. The layers can be doped intentionally to produce either conductivity type, permitting fabrication of junction devices. Although iodine and other impurity atoms are considered, it is concluded that interstitial Ge atoms and lattice vacancies, occurring in unequal numbers at the time of deposition, are the most likely source of the donor and acceptor levels, respectively, and of the observed heat treatment properties.

539.2 : 537.311

11694 THE EFFECT OF DEFORMATION ON THE ENERGY SPECTRUM OF HOLES IN GERMANIUM AND SILICON.

G.E.Pikus and G.L.Bir.

Fiz. tverdogo Tela, Vol. 1, No. 11, 1642-58 (Nov., 1959). In Russian.

A general expression is obtained for the energy spectrum of holes in a uniformly deformed germanium-type lattice. The effect of deformation on the electrical properties of germanium and silicon is discussed briefly for the two limiting cases of high and low temperatures.

A.Tybulewicz

539.2 : 537.311

11695 THE DIFFUSED SHOT-MELTING TECHNIQUE FOR MAKING GERMANIUM AND SILICON P—N JUNCTION DEVICES.

I.A.Lesk.

J.Electrochem. Soc., Vol. 107, No. 6, 534-6 (June, 1960).

The diffused shot-melting technique involves the melting and resolidifying of a piece (conveniently obtained in the form of shot) of semiconductor on a wafer of the same material (having essentially the same melting point) to form a single crystal boundary region, and the subsequent diffusion of impurities across the interface. Shot-melting may be done to quickly that the interface coincides with the original surface of the wafer. Impurity contents of the shot and wafer may be chosen so that a variety of p—n junction devices results after diffusion, and several junctions may be made on the same wafer by this process to form more complex structures. Although lifetime and resistivity changes generally occur, they can often be minimized by subsequent treatment such as alloy gettering or annealing. Simplicity and flexibility of diffused shot-melting have made it a convenient laboratory technique for making many semiconductor devices.

539.2 : 537.311 : 621.382

11696 DIFFUSED JUNCTION DEPLETION LAYER CALCULATIONS.

H.Lawrence and R.M.Warner, Jr.

Bell Syst. tech. J., Vol. 39, No. 2, 389-403 (March, 1960).

Depletion-layer properties have been calculated for diffused junctions in silicon and germanium as a function of reverse voltage and of diffusion parameters for the Gaussian and the complementary error function distributions. These results bridge the gap between the linearly graded behaviour generally exhibited by such junctions at low voltage and the step behaviour exhibited at high voltage. For total depletion-layer thickness and capacitance, the transition from graded to step junction behaviour extends over about one decade of voltage. For depletion-layer thickness n a single side of the junction, it extends over several decades. Depletion-layer thickness and peak electric field are presented graphically as a function of voltage for a variety of junction depths and impurity concentrations. The ranges for which the step and graded junction approximations are valid are apparent from these charts. The results were obtained by an analytical integration of Poisson's equation, and a subsequent use of the I.B.M. 704 for a numerical evaluation of the transcendental equations obtained.

539.2 : 537.311

11697 LOW-TEMPERATURE HALL COEFFICIENT AND CONDUCTIVITY IN HEAVILY DOPED SILICON.

G.A.Swartz.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 245-59 (Feb., 1960).

The Hall coefficient and conductivity of fifteen heavily doped silicon samples have been measured. The Hall-coefficient measurements were generally made in the temperature region 15-300° K, while the conductivity measurements were taken in the region 3-30° K. The general behaviour of the Hall coefficient and conductivity is similar to that in germanium and other semiconductors exhibiting impurity conduction. Two types of impurity conduction were observed: one believed to be non-band conduction and the other, band conduction. Investigation of the temperature region where the transition between normal band conduction and impurity conduction takes place shows a minimum in the impurity conduction resistivity versus reciprocal temperature curve. Comparison of various sample shows that for a given impurity concentration, the lower impurity conductivity is found in the samples containing majority impurity atoms with the larger ionization energy. A possible model for impurity conduction is discussed.

539.2 : 537.311

11698 MEASUREMENT OF THE HALL EFFECT AND CONDUCTIVITY OF SUPER-PURE SILICON.

A.Hoffmann, K.Reuschel and H.Rupprecht.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 284-7 (Oct., 1959).

With the floating-zone technique one has obtained super-pure uncompensated silicon of p-type with a resistivity above 100 000 Ω cm The intrinsic conductivity of these samples reaches near to 40° C. The intrinsic density n_i obtained over a range from 50° to 100° C agrees quite closely with the n_i-values determined by other investigators. The distribution coefficient k of boron is slightly below 0.9.

539.2 : 537.311

11699 THE EFFECT OF GOLD ON THE ELECTRICAL PROPERTIES OF SILICON.

B.I.Boltaks, G.S.Kulikov and R.Sh.Malkovich.

Fiz. tverdogo Tela, Vol. 2, No. 2, 181-91 (Feb., 1960). In Russian.

The experiments were made on single crystals of n- and p-type, with gold diffused either from vapour or from a thin film deposited on the specimen, heating being at 1080-1380° C for 3 to 33 hr. A table shows the surface and volume properties of 19 specimens (5 being controls). In most cases, the nature of the surface conductivity changes (p-type becoming n-type and vice versa). The temperature dependence of chemical potential is calculated for n- and p-type specimens with various Au concentrations and a graph shows the variation of resistivity (at 18° C) with Au concentration for different initial resistivities. Agreement with the tabulated observations is satisfactory except for specimens which were originally n-type and have become p-type after the introduction of gold.

R.Berman

539.2 : 537.311 : 621.382

11700 LIFETIME PRESERVATION IN DIFFUSED SILICON.

M.Waldner and L.Sivo.

J. Electrochem. Soc., Vol. 107, No. 4, 298-301 (June, 1960).

Minority carrier lifetime in silicon, which has been diffused in BCl_3 plus nitrogen at 1100° C, may be in excess of 100 μsec. Diffusion at 1200° C may give lifetimes in excess of 25 μsec. The lifetimes are significantly higher than the values obtained by heat treatment without the BCl_3. A similar effect is observed if chlorine or PCl_5 is added to the nitrogen ambient. Some lifetime preservation after extended heat treatment following the BCl_3 treatment indicates that the glassy layer deposited during the treatment plays a significant role in the process.

539.2 : 537.311

11701 GAMMA IRRADIATION OF SILICON. I. LEVELS IN n-TYPE MATERIAL CONTAINING OXYGEN.

E.Sonder and L.C.Templeton.

J. appl. Phys., Vol. 31, No. 7, 1279-86 (July, 1960).

The resistivity and Hall coefficient of n-type silicon containing oxygen were measured as a function of temperature before and after a number of successive irradiations in a Co^{60} gamma-ray source. A net acceptor level 0.17 eV below the conduction band was observed to result from the irradiation. Its rate of introduction was 7×10^{-4} traps/cm^3 per photon/cm^2 in 50 ohm cm material and was about twice that in more heavily doped material (~2 ohm cm). Acceptor levels, lying deep within the forbidden gap, were also observed. Their total introduction rate was smaller than that of the 0.17 eV level by a factor of 50. A lowering of the mobility below ~100° K was also a result of the irradiations. In heavily irradiated samples this lowering of the mobility was much greater than could be explain on the basis of point-charge scattering.

539.2 : 537.311 : 535.33

ZEEMAN EFFECT OF IMPURITY LEVELS IN SILICON. See Abstr. 11765

539.2 : 537.311 : 538.27

IMPURITY SPIN RELAXATION VIA THE CONDUCTION ELECTRONS IN SILICON. See Abstr. 10241

539.2 : 537.311

11702 INVERSE CHARACTERISTICS WITH THE SURFACE BREAKDOWN OF SILICON p S_p n RECTIFIERS.

.Jantsch.
. Naturforsch., Vol. 15a, No. 4, 302-7 (April, 1960). In German.

From measurements of inverse characteristics, the surface reakdown is studied that occurs when negative acid ions, ozone and ure oxygen are adsorbed on p—n layers formed in silicon of esistivity 1000 ohm cm with a bulk lifetime of 1000 μ sec. Operaion of an unprotected junction in dry N_2 or O_2 at high temperatures or several days likewise leads to surface breakdown: the adsorpion of positive ions results in a reversible effect. G.C.Williams

539.2 : 537.311

11703 UNIFORM SILICON P—N JUNCTIONS. I. BROAD AREA BREAKDOWN.

R.L.Batdorf, A.G.Chynoweth, G.C.Dacey nd P.W.Foy.
. appl. Phys., Vol. 31, No. 7, 1153-60 (July, 1960).

Small area silicon p—n junctions were made which are free from xposed edges and dislocations passing through the space-charge egion. It is believed that the space-charge regions of these juncons more closely resemble plane parallel geometries than any tudied similarly hitherto. The avalanche breakdown phenomena in nese uniform junctions are shown to be drastically different from nose occurring in junctions that contain many dislocations. A comarison is made between the uniform junctions and one that is simiar except that it possesses two breakdown-inducing sites, probably islocations. In the latter junction the reverse characteristic shows vo slightly separated rapid increases in current which coincide, iaswise, with the formation of two isolated light-emitting microlasmas, the occurrence of characteristic microplasma noise, and vo singularities in the charge-multiplication characteristics. The niform junctions show no such phenomena at intermediate voltages, reakdown occuring at a voltage roughly twice that at which the icroplasms form and which was previously thought typical for the iven material resistivity. The light emission pattern accompanying reakdown in the uniform junctions appears more diffuse (giving rise the term — macroplasma) than in nonuniform junctions where it ormally appears as an array of intense local spots (microplasmas). is concluded that microplasmas are not a necessary accompaniment of avalanche breakdown in silicon, but that they tend to occur here there are field or lattice inhomogeneities.

539.2 : 537.311

11704 UNIFORM SILICON P—N JUNCTIONS. II. IONIZATION RATES FOR ELECTRONS.

A.G.Chynoweth.
. appl. Phys., Vol. 31, No. 7, 1161-5 (July, 1960).

Charge multiplication as a function of reverse bias was studied a number of uniform silicon p—n junctions (junctions free from efects which promote local avalanche breakdown sites). From the ultiplication characteristics new data were derived for the field ependence of the ionization rate (α) for electrons. As previously ound in junctions containing dislocations, α obeys the empirical elation $\alpha = \alpha_\infty \exp(-b/E)$, where α_∞ and b are constants and E is e field. Thus, this law is not simply a consequence of distortions the junction introduced by dislocations or other microplasma-ducing defects. The ionization rates and breakdown voltages for e uniform junctions can be made consistent with older data (for onuniform junctions) if the junction fields, as determined from apacitance measurements, in the new junctions are multiplied by 65. The most obvious interpretation of this experimental fact is at breakdown is made relatively easier at defects because the field actually higher by a factor of 1.55. Possible causes of such an hancement are discussed together with alternative hypotheses for e different ionization rates.

539.2 : 537.311

11705 ELECTRIC PROPERTIES OF ALLOYED SILICON CARBIDE P—N JUNCTIONS.

.E.Kharlamova and G.F.Kholnyanov.
iz. tverdogo Tela, Vol. 2, No. 3, 426-33 (March, 1960). In Russian.

The p—n junction is obtained by alloying aluminium and SiC in hydrogen atmosphere; it has a specific resistivity of 2 to 2.5 ohm n and is investigated in the temperature range 20-500°C. Families I–V curves, with temperature as parameter, are plotted, and rembination and diffusion processes are studied in the forward direction. ne diffusion length of holes is determined by the recombination ecay time constant. Leakage effects and reverse current versus oltage characteristics are investigated next, leading at rising applied otential to avalanche breakdowns on the periphery of junctions and in areas of local defects. Junction capacitances and their dependence on temperature and voltage are measured. The practical application of junctions as non-linear, i.e. variable, capacitors is briefly considered. An extensive bibliography is appended. A.Landman

539.2 : 537.311

11706 A STUDY OF THE CONDUCTIVITY AND THE HALL EFFECT IN SOLID SOLUTIONS OF THE AlSb—GaSb SYSTEM.

I.I.Burdiyan and B.T.Kolomiets.
Fiz. tverdogo Tela, Vol. 1, No. 8, 1165-71 (Aug., 1959). In Russian.

Reports a method of preparing comparatively pure solid solutions in the AlSb—GaSb system and gives the results of a study of the electrical conductivity as a function of composition and temperature and of the Hall effect from 110°K to solidus temperatures. A.Tybulewicz

539.2 : 537.311 : 621.383

11707 CATHODE CONDUCTIVITY OF ANTIMONY SULPHIDE FILMS.

Ya.A.Oksman and G.P.Tikhomirov.
Radiotekhnika i Elektronika, Vol. 4, No. 2, 344-6 (Feb., 1959). In Russian.

Electron bombardment of thin dielectric and semiconductor films produces an increase in conductivity and this effect has been used for amplification of photo-emission currents. The limiting value of the gain obtainable at room temperature using antimony sulphide is determined. The maximum gain is found to be over 600, which is greater than that obtained with selenium, arsenic sulphide or aluminium oxide. Details of the measuring apparatus are given. [English summary: PB141106 T-13 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. R.C.Glass

539.2 : 537.311 : 535

ELECTRICAL AND OPTICAL PROPERTIES OF CdO.

See Abstr. 11752

539.2 : 537.311

11708 DEPENDENCE OF THE INDUCED CONDUCTIVITY IN CADMIUM SULPHIDE ON THE ENERGY OF EXCITING ELECTRONS.

S.M.Rȳvkin and B.M.Konovalenko.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1757-61 (Nov., 1959). In Russian.

Answering the criticisms of Bleil, Snyder and Sihvonen (Abstr. 4047 of 1959), the present authors show that their earlier results (Abstr. 4648 of 1955 and 1467 of 1959) on the electrical conductivity of CdS induced by electron bombardment and the results of Bleil et al. agree quite satisfactorily, if differences in the experimental conditions are allowed for. A.Tybulewicz

539.2 : 537.311 : 535.33

11709 INVESTIGATIONS OF Cs—Sb LAYERS.

C.Kunze.
Ann. Phys. (Leipzig), Vol. 6, No. 1-2, 89-106 (1960). In German.

Reports a comprehensive study of the electrical, optical and photoelectric properties of semiconducting layers of CsSb and Cs_3Sb, including a review of previous work. The layers are prepared in vacuo: full details of apparatus are given. Measurements of the variation of dark conductivity with temperature suggest the presence of two impurity levels at depths below the conduction band of 0.63 and 0.53 eV for CsSb, and 0.98 and 0.30 eV for Cs_3Sb. For Cs_3Sb, the spectral sensitivity curve for photoconductivity shows a peak at about 1.8 eV, and the photoemission curve shows some structure at about 2.3 eV. The effect of oxygen at a pressure of about 10^{-4} mm Hg on the photoelectric properties of the layers is also investigated. C.H.B.Mee

539.2 : 537.311

11710 VARIATION OF THE WORK FUNCTION OF OXIDE SEMICONDUCTORS BY ALLOYING ADDITIONS.

E.Kh.Enikeev, L.Ya.Margolis and S.Z.Roginskii.
Dokl. Akad. Nauk SSSR, Vol. 130, No. 4, 807-9 (Feb. 1, 1960). In Russian.

It was shown that the work function ψ of CuO, NiO and ZnO could be varied within wide limits by the introduction of small quantities of modifying additions, such as Li_2O, Na_2O, Cs_2O, ThO_2, $ZnSO_4$, Fe_2O_3, Cr_2O_3 and MgO. Thus, for instance, ψ of ZnO decreased by 0.8 eV or increased by 0.4 eV after the introduction of 2% of Na_2O or ThO_2, respectively. Correlation of the concentration dependence of ψ of various solid solutions with the published data on the variation of electrical conductivity of these systems revealed the complex nature of the relationship between the volume and surface electrical properties of modified semiconductors. M.H.Sloboda

539.2 : 537.311

11711 PROPERTIES OF p-TYPE GaAs PREPARED BY COPPER DIFFUSION.

F.D.Rosi, D.Meyerhofer and R.V.Jensen.
J. appl. Phys., Vol. 31, No. 6, 1105-8 (June, 1960).

Purification of arsenic by hydrogen sublimation and gallium by vacuum annealing resulted in the preparation of high resistivity ($\sim 10^5$ ohm cm), n-type GaAs crystals by the horizontal Bridgman technique. Conversion of this material to p-type was accomplished by the inward diffusion of copper from the crystal surface. Measurements of Hall mobility as a function of hole concentration in the range, 2×10^{16} cm^{-3} to 3×10^{17} cm^{-3}, at room temperature showed a dependence which is consistent with theory. The analysis suggests a lattice mobility for holes of 450 cm^2 V^{-1} sec^{-1} at 300°K. The mobility varied approximately as $T^{-2.3}$ in the range $76\text{-}300^\circ$K. At the low temperatures the number of ionized impurities ranged from 2×10^{15} cm^{-3}. The energy levels associated with copper in GaAs are 0.023 eV and 0.15 eV above the valence band.

539.2 : 537.311

11712 INVESTIGATIONS OF THE HALL EFFECT AND THERMOELECTRIC PROPERTIES OF GALLIUM ARSENOSELENIDE. I.Feltin'sh.

Latv. PSR Zinat. Akad. Vestis, Vol. 12(149), 61-4 (1959).
In Russian.

Electrical conductivity, Hall, effect, and thermoelectric power were measured between 90 and 570°K for several specimens of compositions ranging from GaAs to Ge_2Se_3. The resistivity varied from 10^3 to 10^{-3} ohm cm at room temperature. The Hall constant was found to be independent of field (2-20 kiloersteds) and almost independent of temperature, being $-R = 52$, 0.9, 2.3 and 38 $cm^3A^{-1}sec^{-1}$ for 0, 1.72, 4.55 and 10.00 mol.% Ga_2Se_3 respectively. The electron concentrations and mobilities were computed and the latter found to be almost constant at 1600 $cm^2V^{-1}sec^{-1}$. In other specimens the Hall voltage was too small to be measured but rough estimates indicated that at higher concentrations of Ga_2Se_3 the mobility decreased very rapidly indicating the presence of structural defects. The thermoelectric power (α) was found to decrease slightly with increasing temperature; during increase of the Ga_2Se_3 component, α decreased to -700 $\mu V/^\circ K$ for 25% and then increased and became positive above 70% Ga_2Se_3. D.J.Huntley

539.2 : 537.311

11713 CARRIER CONCENTRATION AND HOLE MOBILITY IN p-TYPE GALLIUM PHOSPHIDE.

G.F.Alfrey and C.S.Wiggins.
Z. Naturforsch., Vol. 15a, No. 3, 267-8 (March, 1960).

The Hall coefficient and conductivity for a single crystal of GaP were measured between 100°K and 400°K and from these were deduced the carrier concentration and mobility as a function of temperature.. These data lead the authors to suggest that an acceptor level exists at about 0.04 eV above the valence band, and that the scattering is acoustic mode. The room temperature hole mobility of 66 cm^2 V^{-1} sec^{-1} is in agreement with the measurements and predictions of other workers. I.Cooke

539.2 : 537.311

11714 ESAKI DIODE IN InSb.

R.L.Batdorf, G.C.Dacey, R.L.Wallace and D.J.Walsh.
J. appl. Phys., Vol. 31, No. 3, 613-14 (March, 1960).

Devices made from InSb should show Esaki effect (Abstr. 2314 of 1958) at lower dopings or with wider transition regions than in Ge, because of the low effective mass of the carriers. The product RC should then be smaller. V—I characteristics are given for a diode at temperatures from 78° to 299°K. It is deduced that in the negative resistance region $R \sim -0.2$ ohm and $C \sim 25$ $\mu\mu F$, giving $RC \sim 5 \times 10^{-12}$ sec. Results are given for experiments on a poorer InSb diode ($RC = 10^{-8}$) as a r.f. oscillator, and a circuit described which produced, at a repetition rate of 160 Mc/s,. pulses 0.4 mμsec long at the base but without the square shape of an ideal diode. R.Berman

539.2 : 537.311

11715 INTERNAL FIELD EMISSION AT NARROW P—N JUNCTIONS IN INDIUM ANTIMONIDE.

A.G.Chynoweth and R.A.Logan.
Phys. Rev., Vol. 118, No. 6, 1470-3 (June 15, 1960).

The field and temperature dependence of internal field emission in narrow p—n junctions in indium antimonide was studied. Relatively good agreement, both qualitative and quantitative, is obtained between the experimental results and the usual expression for the barrier transparency. From studies of Esaki characteristics at low temperatures and from the observed temperature dependence of the tunnelling current, it is confirmed that the tunnelling transitions do not involve phonons. Also, it is shown that the temperature dependence of the barrier transparency is determined by that of the energy gap at $k = 0$.

539.2 : 537.311

11716 ELECTRON MOBILITY OF INDIUM ARSENIDE PHOSPHIDE [$In(As_yP_{1-y})$]. H.Ehrenreich.

J. Phys. Chem. Solids, Vol. 12, No. 1, 97-104 (Dec., 1959).

The electron mobility of InP, InAs and of the alloys $In(As_yP_{1-y})$ is calculated using existing evidence for the band structure of these materials and shown to be determined primarily by a combination of polar optical mode and charged impurity scattering between about 200 and 500°K. The mobility of $In(As_yP_{1-y})$ as a function of y at room temperature calculated on the basis of these scattering mechanisms agrees within about 30% with the experimental data of Weiss. These calculations are performed without use of adjustable parameters. The experimental information necessary to determine the conduction band structure and the quantities entering the mobility of InP and InAs is available. The band structure and the electron effective mass of the alloys can be established reasonably well from existing experimental evidence. A linear interpolation procedure is used to deduce the remaining quantities entering the mobility. The validity of this procedure can be checked experimentally. The disagreement between theory and experiment in the alloy arises in part from a 25% discrepancy for InAs. When the calculated and experimental mobilities are matched for InAs and InP by adjusting the effective ionic charge, the shapes of the calculated and experimental curves are found to agree fairly well for the energy range of y. This indicates that alloy scattering, arising specifically from the disorder of the lattice, does not play a dominant role in determining the electrical properties of the alloy.

539.2 : 537.311

11717 ELECTRICAL PROPERTIES OF SELENIUM WITH GOLD IMPURITY. V.G.Sidyakin.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1172-5 (Aug., 1959). In Russian.

The electrical conductivity and thermoelectric power of pure selenium and of selenium doped with 0.001, 0.005, 0.01, 0.6 and 1.0% by weight of gold were studied. A layer of gold of known weight was sputtered on to a thin plate of amorphous selenium, this plate was ground and samples were pressed out at 15 000 atm; the samples were subsequently annealed for 4 hr at 160°C. Introduction of gold reduced the conductivity (the greatest reduction occurred with 1% of gold). The thermoelectric power showed that gold-doped selenium is of n-type. The results obtained were explained on the basis of the layered structure of hexagonal selenium. A.Tybulewicz

539.2 : 537.311 : 548.5

RESISTANCE CHANGES OF THIN Se LAYERS FROM ROOM TEMPERATURE TO MAXIMUM CRYSTALLIZATION TEMPERATURE. See Abstr. 10282

539.2 : 537.311

11718 THE RELATIONSHIP BETWEEN ELECTRICAL CONDUCTIVITY AND WORK FUNCTION OF MODIFIED ZINC OXIDE.

V.I.Vladimirova, E.Kh.Enikiev, G.M.Zhabrova and L.Ya.Margolis.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 2, 342-5 (March 11, 1960).
In Russian.

To check the hypothesis that the activity of semiconducting catalysts is directly related to their electrical conductivity σ, a comparative study was made of the work function φ and the activation energy of σ, E_σ, of ZnO specimens whose φ was varied by the addition of Na_2O, Li_2O, $ZnSO_4$ and ThO_2. The results indicated that in many cases the variation of the Fermi level on the surface of modified catalysts cannot be equivalently determined from the variation of σ, and that the attempts to establish a quantitative relationship between their catalytic activity and σ, without a detailed study of the distribution of the modifying additions on the surface and in the volume of the catalyst, may lead to false conclusions. M.H.Sloboda

hotoconductivity

539.2 : 537.312

11719 QUANTUM OSCILLATIONS OF THE PHOTOELECTRIC YIELD OF METALS IN A MAGNETIC FIELD.
.E.Zilberman and I.O.Kulik.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1188-200 (April, 1960).
n Russian.

Quantum oscillations of the volume (external) photoelectric ef-ect in metals in a magnetic field are investigated in the ultraviolet egion of the spectrum for electrons possessing an arbitrary dis-ersion law. Besides oscillations of the de Haas—van Alphen type he expression for the photocurrent contains some new terms which re also characteristic of other optical phenomena. It is shown that . study of the photocurrent oscillations and photoelectron energy dis-ribution function permits one in principle to determine the shape of he Fermi surface, as well as the arrangement of separate electron roups in the inverse lattice and also to determine the shape of iso-nergetic surfaces lying below the Fermi surface. The calculation is erformed for the case when the magnetic field is perpendicular to he surface. The influence of photoelectron collisions prior to exit rom the metal on oscillations of the photoelectron yield is onsidered.

539.2 : 537.312

11720 THEORY OF PHOTOELEMENTS WITH A P—N JUNCTION. B.Ya.Moizhes.
iz. tverdogo Tela, Vol. 2, No. 2, 221-6 (Feb., 1960). In Russian.

The characteristic of a photoelement is examined by a calcu-ation of the distributed resistance of a current-carrying layer. The nfluence of a concentration gradient in the surface layer of a photo-lement on its quantum yield is also investigated. K.N.R.Taylor

539.2 : 537.312

11721 PHOTOEFFECTS IN NONUNIFORMLY IRRADIATED p—n JUNCTIONS. G.Lucovsky.
. appl. Phys., Vol. 31, No. 6, 1088-95 (June, 1960).

A theoretical basis is provided for the interpretation of photo-ffects observed in nonuniformly irradiated p—n junctions. Differ-ntial equations describing the junction photovoltage are developed hrough an application of the continuity and diffusion equations. olutions of the small-signal steady-state photoeffect equation ndicate that the effects of nonuniform irradiation become increas-ngly important as the ratio of the lateral to the transverse resist-nce increases. α, a parameter introduced in this paper and esignated as the lateral fall-off parameter, is a measure of this esistance ratio. The lateral photovoltage resulting from nonuniform rradiation can be eliminated by reverse biasing the junction into aturation. Experimental curves in agreement with the predictions f the analysis are presented.

539.2 : 537.312

11722 PHOTOCONDUCTION IN TERNARY V—VI—VII COMPOUNDS. R.Nitsche and W.J.Merz.
. Phys. Chem. Solids, Vol. 13, No. 1-2, 154-5 (May, 1960).

Some photoelectric properties of single crystals of ternary ompounds of the type V—VI—VII (V = Sb, Bi; VI = S, Se, Te; II = Cl, Br, I) were studied. The wavelengths of maximum photo-urrent, λ_{max} shift in a regular way towards longer wavelengths with ncreasing atomic weight of the components. For the compounds bSBr and SbSI the dependence of photocurrent, dark current and $_{max}$ on temperature was measured between −140 and +120°C.

539.2 : 537.312

11723 A CADMIUM TELLURIDE PHOTOELEMENT WITH A P—N JUNCTION. Yu.A.Vodakov, G.A.Lomakina, .P.Naumov and Yu.P.Maslakovets
iz. tverdogo Tela, Vol. 2, No. 1, 3-7 (Jan., 1960). In Russian.

Photoelements with p—n junctions in cadmium telluride were repared from both n- and p-base material. The voltage—current haracteristics and spectral sensitivity of these elements was xamined. K.N.R.Taylor

539.2 : 537.312

11724 VOLT—AMPERE CHARACTERISTICS OF THE PHOTO-ELECTRON EMISSION OF GERMANIUM.
.G.Borzyak, P.M.Marchuk and O.G.Sarbei.
iz. tverdogo Tela, Vol. 2, No. 2, 306-13 (Feb., 1960). In Russian.

Describes a baked and sealed-off glass vacuum system in which . photoelectric cathode using a layer of germanium as a sensitive urface can be prepared. Barium oxide is laid down on the surface to reduce the work function and finally the processed photo-cathode is lowered into an anode in the form of a spherical grid without breaking the vacuum. Measurements are carried out at a pressure of about 5×10^{-9} mm. The measured photo-emission characteristics of such layers suggests that a surface rather than a volume photo-effect occurs. T.Mulvey

539.2 : 537.312

11725 PHOTOELECTRIC EMISSION OF GERMANIUM AND SILICON IN THE AMORPHOUS AND CRYSTALLINE STATES. P.G.Borzyak, L.S.Miroshnichenko and O.G.Sarbei.
Fiz. tverdogo Tela., Vol. 2, No. 2, 314-18 (Feb., 1960). In Russian.

Describes an arrangement for measuring the photoelectric properties of photocells using photo-cathodes of germanium and silicon, respectively, whose work function has been lowered by putting barium oxide on to the surface. Photo-cathodes in either the crystalline or the amorphous state were prepared in situ in a sealed-off vacuum system and the photo-emission characteristics measured. These were found to be influenced by the crystallographic state of the material. The results are in good agreement with optical absorption spectra. T.Mulvey

539.2 : 537.312

11726 PREPARATION OF AN InSb BARRIER-LAYER PHOTOVOLTAIC CELL WITH AN ALLOYED p—n JUNCTION.
V.V.Galavanov and N.A.Erokhina.
Fiz. tverdogo Tela, Vol. 1, No. 8, 1198-200 (Aug., 1959). In Russian.

Monocrystalline n-type InSb with impurity densities from 10^{13} to 10^{17} cm^{-3} was used. The crystal surfaces were ground and etched in CP-4. Alloying was carried out in graphite crucibles in an argon atmosphere or in vacuo, and the alloying element was cadmium or indium. The photo-e.m.f. and its temperature dependence were governed by the purity of InSb, the surface treatment and the temperature and duration of alloying. The rectification factor of the p—n junctions was 3 - 4. A.Tybulewicz

539.2 : 537.312 : 621.383

11727 INFLUENCE OF CRYSTAL SIZE ON THE SPECTRAL RESPONSE LIMIT OF EVAPORATED PbTe AND PbSe PHOTOCONDUCTIVE CELLS.
W.D.Lawson, F.A.Smith and A.S.Young.
J. Electrochem. Soc., Vol. 107, No. 3, 206-10 (March, 1960).

Photoconductive layers of PbTe were formed by evaporation on substrates at different temperatures. The size of crystals in the layers was estimated from electron micrographs and X-ray diffraction, and a correspondence was obtained between crystal size and the limit of spectral response. Sensitivity up to the long wavelength limit set by the energy gap is not achieved unless the crystals are greater than a critical size; for lead telluride this is about a quarter of a micron. A similar effect has been shown to occur with PbSe.

539.2 : 537.312

11728 THE RELATIONSHIP BETWEEN THE PHOTOELECTRIC PROPERTIES OF AN ELECTROPHOTOGRAPHIC LAYER AND THE PROPERTIES OF A "LONGITUDINAL" PHOTORESISTOR.
P.M.Podvigalkin.
Optika i Spektrosk., Vol. 8, No. 1, 146-8 (Jan., 1960). In Russian.

Dynamic properties of an electrophotographic layer (a photosensitive semiconductor, usually selenium or zinc oxide, on a conducting base) during and immediately after illumination are related to its steady-state properties as a "longitudinal" photoresistor. A.Tybulewicz

539.2 : 537.312 : 538.27

11729 PARAMAGNETIC RESONANCE DETECTION OF TRAPPING IN A PHOTOCONDUCTOR. R.S.Title.
Phys. Rev. Letters, Vol. 4, No. 10, 502-3 (May 15, 1960).

A small resonance signal for 0.02 mol% of Gd ions in ZnS crystals is markedly increased by radiation which also gives photoconduction. The enhanced resonance decays slowly in the dark and is "quenched" by radiation which also quenches phosphorescence. An additional quenching band is found at 280-335 mμ. Photoconductivity is conveniently observed by loss effects in the resonance cavity. G.F.J.Garlick

Thermoelectric Properties

539.2 : 537.32

11730 DETERMINATION OF THE EFFECTIVE SCATTERING MECHANISM PARAMETER OF ELECTRON TRANSPORT THEORY. T.C.Harman.
Phys. Rev., Vol. 118, No. 6, 1541-2 (June 15, 1960).

For Corbino disk geometry, the variation of thermoelectric power α with magnetic-field strength H is a strong function of the scattering and a weak function of the Fermi level. The zero magnetic-field thermoelectric power is a strong function of the Fermi level and a weak function of the scattering. Thus, measurements of $\Delta\alpha/\alpha(0)$ versus H and $\alpha(0)$ at a particular impurity concentration and temperature should yield a scattering parameter and a Fermi level separately. The transport equation for $\Delta\alpha/\alpha(0)$ has been derived for the case of a simple spherically symmetric energy band, arbitrary scattering, exact statistics, and Corbino disk geometry. The thermoelectric power increased 55% as the magnetic field increased to 22 kG for mercuric selenide. Although there is some evidence which indicates that the simple band form does not occur in HgSe, a preliminary comparison of theory and experiment showed satisfactory agreement.

539.2 : 537.32

11731 INJECTION HEAT TRANSFER.
V.I.Stafeev.
Fiz. tverdogo Tela, Vol. 2, No. 3, 438-44 (March, 1960). In Russian.

The origin of the Peltier effect in a semiconducting diode with a p–n junction is discussed for various recombination conditions. For recombination in the space-charge layer, when the forward current flows, the contact with the metal cools and the p–n junction heats up. The reverse happens for recombination at the metal-semiconductor contacts. An asymmetrical diode ($N_A \gg N_D$) is considered and values of Π and α are derived for small current flow. If an injection diode could be made of the low heat conductivity materials used in cooling devices, it should be possible to achieve temperature differences of tens of degrees in one element. The heat transferred is always more than in a device working on the usual Peltier mechanism. More power is used to maintain the carrier concentration. R.Berman

539.2 : 537.32

11732 THE VOLUME GRADIENT THOMSON EFFECT
P.I.Baranskii.
Fiz. tverdogo Tela, Vol. 2, No. 3, 445-57 (March, 1960). In Russian

It is shown experimentally that there is a temperature gradient within the volume of an inhomogeneous Ge single crystal when current flows: $|\text{grad } T| \propto I^2$. A method is described for measuring the volume gradient Thomson effect associated with this gradient. For small currents, this method could be used for the volume gradient Peltier effect. The Thomson effect is given by $Q_{vg} = \tau\,(dT/dx) = \text{const. } I^3$. The volume gradient e.m.f. previously measured (Abstr. 4588 of 1959) cannot then be ascribed to Thomson effect influence on temperature gradients. R.Berman

539.2 : 537.32

11733 DEPENDENCE OF THE BULK PELTIER EFFECT ON THE GRADIENT OF THE SPECIFIC RESISTANCE.
P.I.Baranskii and P.M.Kurilo.
Fiz. tverdogo Tela, Vol. 2, No. 3, 458-62 (March, 1960). In Russian.

In single crystal germanium the bulk Peltier voltage E was shown experimentally to be proportional to the current and to depend on the resistivity ρ as $E \propto \rho^{-1}(d\rho/dx)$. D.J.Huntley

539.2 : 537.32

11734 THE SEEBECK COEFFICIENT OF BISMUTH SINGLE CRYSTALS. B.S.Chandrasekhar.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 268-73 (Oct., 1959).

The Seebeck coefficient S of single crystals of bismuth has been measured between room temperature and about 250°C. The results are used to resolve a discrepancy in the data on the Seebeck coefficient of polycrystalline bismuth as given by Sato and by Savornin and Poggi; the values given by the latter workers are shown to be more reasonable. The anisotropy in S at 300°K is analyzed in terms of the current model for the carriers in bismuth. Abeles and Meiboom's results from magnetoresistance measurements and the present data are used to calculate the density-of-states effective masses of the electrons and holes respectively. The value for the electrons agrees well with that deduced from de Haas–van Alphen effect and cyclotron-resonance experiments. The value for the holes is very close to that deduced from cyclotron resonance, but much smaller than is suggested by electronic heat-capacity data.

539.2 : 537.32

11735 THE EFFECT OF STRAIN ON THE SEEBECK COEFFICIENT OF N-TYPE GERMANIUM.
J.R.Drabble and R.D.Groves.
J. Phys. Chem. Solids, Vol. 12, No. 3-4, 285-94 (Feb., 1960).

The effect of uniaxial strain on the Seebeck coefficient of n-type germanium has been studied in the temperature range where phonon-drag effects are important. The changes in the Seebeck coefficient were found to be closely correlated with the changes in the resistivity under the same conditions. The theory of the effect is discussed, and it is shown that the measurement of both these changes leads in a fairly direct way to an estimate of the anisotropy of the phonon-drag part of the Peltier tensor for a single valley. Results are presented and analysed for a number of specimens.

Dielectric Properties

539.2 : 537.2

11736 THE EFFECTIVE FIELDS IN CRYSTALS.
Yu.V.Bogomolov.
Fiz. tverdogo Tela, Vol. 2, No. 2, 297-301 (Feb., 1960). In Russian.

A generalization of the Lorenz–Lorentz formula is given for the case of a crystal and includes terms up to the order of α^3 (α is the polarizability). To this approximation, the "crystal" polarizabilities of the naphthalene molecule have been calculated as $(\alpha_1, \alpha_2, \alpha_3) = (10.2, 15.4, 26.3) \times 10^{24}\ \text{cm}^{-3}$. The usual Lorenz–Lorentz formula gives (12.3, 18.6, 21.4), as compared with Sundrarajan's values (Abstr. 1442 of 1936) of (10, 19, 27). A.L.Mackay

539.2 : 537.2

11737 PERMITTIVITY AND DIELECTRIC LOSSES OF ALKALI-HALIDE CRYSTALS. V.V.Panchenko.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1727-9 (Nov., 1959). In Russian.

LiF, NaF, NaCl, KCl and KBr were investigated at 20-550°C in fields of 10^5-10^7 c/s. Two relaxation maxima were found in the $\tan \delta = f(t)$ curves (t is the temperature). These maxima moved to higher temperatures at higher frequencies, and they were accompanied by barely noticeable inflections on $\epsilon = f(t)$ curves. Permittivity ϵ rose almost linearly with temperature at lower temperatures and more rapidly at higher temperatures. The activation energies of the relaxing groups were close to the values obtained by Breckenridge (Abstr. 1231 of 1949; 8723 of 1950) at audio frequencies, but they were 3-4 times smaller than the conduction activation energies. The observed relaxation losses were ascribed to quasi-dipoles formed by vacancies of opposite signs, or by vacancies and impurity ions; dislocations may also play some part. A.Tybulewicz

539.2 : 537.2

11738 EXPERIMENTAL STUDY OF THE VARIATIONS OF DIELECTRIC CONSTANT ASSOCIATED WITH A PHASE CHANGE. S.Le Montagner.
Ann. Phys. (Paris), Ser. 13, Vol. 5, No. 3-4, 469-508 (March-April, 1960). In French.

The variations with temperature of the complex dielectric constants of ammonium sulphate, ammonium alum and the ferroelectric alkali metal phosphates and arsenates have been determined using the wide frequency range of 100 c/s to 24 000 Mc/s. Single crystal and powder specimens of ammonium sulphate were used and the results indicate that Debye dipolar absorption occurs in each phase, but with different activation energies. The activation energy was determined for the low temperature phase, but could only be estimated for the other phase because the maximum of the ϵ'' versus temperature plot, for the highest frequency available, lay below the transition point. Adsorbed water was found to lower the transition temperature from about 240°K to 224°K. With ammonium alum the maximum of the real part of the dielectric constant shifts to higher temperatures for higher frequencies. This behaviour is explained using Debye theory while assuming that a phase change occurs. Measurements on powder specimens at low frequencies showed discontinuities in the ϵ' versus temperature plot at 55°K and 75°K which were not observed with fused specimens. The 55°K discontinuity fits the theory and it is suggested that the other one might be associated with an orientation effect. The absorption of the ferroelectric materials is very dependent on temperature and three types of behaviour were noted. The imaginary part of the dielectric constant has a maximum which may shift to higher temperatures for higher frequencies, but it is more usual for the position of the aximum to be independent of frequency. Alternatively there may e either one or several maxima which are shifted by a change of requency, the form of the ϵ'' versus temperature curve being tered as well. A.S.Kay

539.2 : 537.2

11739 INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE ELECTRIC AND ELASTIC PARA- ETERS OF CANCRINITE. V.A.Koptsik and L.A.Ermakova.
iz. tverdogo Tela, Vol. 2, No. 4, 697-700 (April, 1960). In Russian.

The projection of the cancrinite structure on the basal plane is ven, together with the temperature variation between + 20 and 140°C of (i) d_{15}, s_{44} and ϵ_{11}, and (ii) d'_{32}, s'_{22} and ϵ'_{33} for ZYX 45° d ZYX 75° sections. The results are discussed in relation to the ructure. See also Abstr. 634 of 1960. R.F.S.Hearmon

539.2 : 537.2

11740 DIELECTRIC HYSTERESIS IN PYROLUSITE.
V.G.Bhide, R.V.Damle and R.H.Dani.
hysica, Vol. 25, No. 7, 579-80 (July, 1959).

Samples with a permittivity of 10^5 are reported. Unlike many xide semiconductors, pyrolusite shows negligible dispersion at udio frequencies. Spontaneous polarization occurs below 55°C, but ransition to a non-ferroelectric state takes place at higher temperares. The transition temperature is affected by mechanical presure and d.c. bias. J.H.Mason

539.2 : 537.2

11741 INFLUENCE OF EXPOSURE TO X-RAYS ON THE ANOMALOUS PROPERTIES OF ROCHELLE SALT.
.N.Karmen.
iz. tverdogo Tela, Vol. 2, No. 4, 679-84 (April, 1960). In Russian.

Prepolarized Rochelle salt plates were exposed to 35 kV X-rays or various periods. The shape of the hysteresis loops as affected y time of irradiation and by the presence of an alternating or connuous electric field is shown graphically. The results are considred in relation to the presence of defects in the material.
R.F.S.Hearmon

539.2 : 537.2

11742 THE DEPENDENCE OF THE DIELECTRIC CONSTANT OF ADP ON THE TEMPERATURE. J.Kraus.
zech. J. Phys., Vol. 9, No. 3, 409 (1959).

The dielectric constants and loss tangents for plates of Z, X, Y nd S cuts are given for the temperature range 20-80°C. The dielecric constants for the Z and X cuts increased with temperature above 0°C, contrary to previously published results. R.C.Kell

539.2 : 537.2

11743 BIAS IN FERROELECTRIC COLEMANITE.
E.Fatuzzo.
. appl. Phys., Vol. 31, No. 6, 1029-34 (June, 1960).

The question of the existence of an intrinsic bias in colemanite bove the Curie point is studied and compared with experimental esults. It is concluded that bias does exist above the Curie point nd that it is completely responsible for the pyroeffect experimentally bserved there. Some formulae are derived, connecting the pyroffect and the intrinsic bias, and are compared with data available the literature.

539.2 : 537.2

11744 ON SURFACE LAYERS OF $BaTiO_3$.
B.Březina and V.Janovec.
zech. J. Phys., Vol. 9, No. 6, 758 (1959).

Above the Curie point, a-domain crystals remain birefringent ear one of the two surfaces perpendicular to the polarization irection. A possible explanation of the mechanical stress near the urface layer is given. R.C.Kell

539.2 : 537.2

11745 DIELECTRIC PROPERTIES OF SINGLE CRYSTALS OF $SrTiO_3$ AT LOW TEMPERATURES. H.E.Weaver.
. Phys. Chem. Solids, Vol. 11, No. 3-4, 274-7 (Oct., 1959).

The behaviour with temperature variation of the "small-signal" ielectric constant of single crystals of $SrTiO_3$ has been measured rom 296 down to 1.4°K, with a maximum value of 18 000 at 1.4°K. he temperature-dependence of the dielectric constant was observed deviate from the classical Curie—Weiss law at ~50°K. The D—E urves ("large-signal") show a remnant or "spontaneous" polarizaon, and hence hysteresis, beginning at 45°K. A maximum value of the saturation polarization of $1.5\,\mu C/cm^2$ was observed at 1.4°K. These data are taken as evidence of ferroelectricity in $SrTiO_3$ below 45°K.

539.2 : 537.2

11746 ANTIFERROELECTRIC AND FERROELECTRIC PROPERTIES OF THE $NaNbO_3-PbZrO_3$ SOLID SOLUTIONS. N.N.Krainik.
Fiz. tverdogo Tela, Vol. 2, No. 4, 685-90 (April, 1960). In Russian.

Reports the preparation and an investigation of the dielectric properties of the solid solutions of two antiferroelectrics: $NaNbO_3$ and $PbZrO_3$. Within fairly definite temperature and composition ranges ferroelectric phases were discovered. A.Tybulewicz

539.2 : 537.2

11747 A PIEZOELECTRIC EFFECT IN PHOTOELECTRETS.
I.S.Zheludev and V.M.Fridkin.
Kristallografiya, Vol. 3, No. 3, 315-21 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 319-24 (May-June, 1958).

A piezoelectric effect in photoelectrets was observed and investigated. The electric charge and the piezoelectric moduli were measured in a photopolarized single crystal of anthracene. Reductions in the charge and in the piezoelectric modulus d_{33} of the single crystal were studied during its depolarization in the dark. Tests show that the piezoelectric effect in photoelectrets may be completely explained by a change in the magnitude of the electric polarization as a result of stress-induced changes in the geometric size of the specimen.

539.2 : 537.2

11748 THE EFFECT OF PRESSURE ON PIEZOELECTRIC PROPERTIES OF BARIUM TITANATE. B.A.Rotenberg.
Fiz. tverdogo Tela, Vol. 1, No. 12, 1777-81 (Dec., 1959). In Russian.

The piezoelectric polarization, P, induced in barium titanate was studied using hydrostatic (three-directional) and unidirectional pressure on monocrystals, and using hydrostatic, two-directional and unidirectional pressure on polycrystals ($BaTiO_3$ ceramics). On hydrostatic compression the piezoelectric polarization varied linearly with pressure up to 1000 kg/cm². The anomalous behaviour of the piezoelectric polarization on unidirectional and two-directional compression (maxima and a change of sign of P at high pressures) was due to domain re-orientation by mechanical stresses.
A.Tybulewicz

539.2 : 537.2

11749 THE PIEZOELECTRIC, ELASTIC, AND DIELECTRIC PROPERTIES OF CRYSTALS OF $MgSO_4.7H_2O$.
A.A.Voronkov.
Kristallografiya, Vol. 3, No. 6, 716-19 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 722-5 (Jan., 1960).

Determined by the dynamic method. The temperature dependence of these constants was measured in the region of room temperature.

539.2 : 537.2

11750 ELECTROSTRICTION OF LINEAR DIELECTRICS.
I.S.Zheludev and A.A.Fotchenkov.
Kristallografiya, Vol. 3, No. 3, 308-14 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 312-18 (May-June, 1958).

Four possible equations describing the electrostriction of linear dielectrics are derived. New electrostriction coefficients, R_{ijmn}, C_{ijmn}, and H_{ijmn} are introduced and the relationship between all the coefficients is given in tensor form. The electrostriction coefficients R_{ijmn} for "Eskapon", NaCl and Z-cut quartz were measured by the method of "linearized" electrostriction.

OPTICAL PROPERTIES OF SOLIDS

539.2 : 535

11751 OPTICAL PROPERTIES OF A HIGHLY BORON-DOPED SILICON SURFACE. J.F.Hall, Jr.
J. Opt. Soc. Amer., Vol. 50, No. 7, 717-20 (July, 1960).

The index of refraction and extinction coefficient of a silicon surface highly doped with boron so as to appear as a semimetal are determined from the specular reflection. The classical theory of metals is employed to obtain a relationship between the optical and electrical properties. The results are substantiated by comparing the calculated and measured reflectance of silicon-monoxide layers of known optical properties deposited on the doped silicon surface.

539.2 : 535 : 537.311

11752 ON THE RELATION BETWEEN THE OPTICAL ABSORPTION AND DISPERSION AND THE CONDUCTION MECHANISM OF THIN CADMIUM OXIDE LAYERS.

H.Finkenrath.

Z. Phys., Vol. 158, No. 5, 511-32 (1960). In German.

Measurements of electrical conductivity, Hall effect, and thermoelectric power, as well as optical absorption and dispersion in the near infrared, were made on cathode-sputtered CdO layers. The optical properties are almost entirely dominated by the high free-electron concentration. Deviations from classical absorption theory follow from the energy dependence of the mean time between electron—phonon collisions. The optical data provide an explanation for the electrical behaviour of the layers. The electron effective mass is found to be 0.14 m. C.A.Hogarth

539.2 : 535 : 536.48

ABSORPTION OF ELECTROMAGNETIC RADIATION IN SUPERCONDUCTORS. See Abstr. 10845

539.2 : 535

11753 OPTICAL PROPERTIES OF COPPER.

S.Roberts.

Phys. Rev., Vol. 118, No. 6, 1509-18 (June 15, 1960).

Optical properties of solid copper were measured in wavelength range from 0.365 to 2.5 μ and at temperatures 90°, 300° and 500°K. Annealed and electropolished specimens were used. Measurements were done in a vacuum of about 2×10^{-6} mm Hg and it was observed that the oxide film which normally forms on copper upon exposure to air could be removed in vacuum to a temperature of 500°K. In the wavelength range below 0.6 μ the data confirm the well-known facts relating to a threshold for interband electronic transitions. At longer wavelengths the optical properties are determined almost entirely by free electrons. Deviations from simple theory are partly explained by the anomalous skin effect and it is concluded that the electronic collisions at the metal surface are diffuse. However, it is shown that the anomalous skin effect is not sufficient to explain the observed deviations and that a more complete interpretation ought to consider the nonspherical nature of the Fermi surface and variation of the relaxation time over this surface.

539.2 : 535.32

11754 OPTICAL CONSTANTS OF ALUMINIUM.

H.Mendlowitz.

Proc. Phys. Soc., Vol. 75, Pt 5, 664-70 (May, 1960).

The optical constants of aluminium from the near ultraviolet (2500 A) to the near infrared (5 μ) can be described, at least qualitatively, in terms of the Drude formula by the two parameters N and τ, the density of free electrons and the relaxation time, respectively. The value for N is taken to correspond to 2.4 free electrons per atom and the value for τ is taken to be 1.2×10^{-15} sec.

539.2 : 535.33

11755 ABSORPTION AND EMISSION SPECTRA OF AN ELECTRON IN A ONE-DIMENSIONAL DEEP TRAP.

B.S.Gourary and A.A.Maradudin.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 88-104 (May, 1960).

The wave-functions and the energies of the bound states of an electron in a special one-dimensional deep trap are calculated. Only two essential approximations are made in the course of the treatment, namely the Born—Oppenheimer approximation for the separation of the electronic and the nuclear motions, and the harmonic approximation for the lattice energy. Further approximations are also made, but these are not essential to the calculation and they can be avoided, if necessary. Green's function techniques are employed in the solution of the electronic and the lattice vibration problems, and they make possible the treatment of both the localized and the extended lattice vibration modes and their influence on the electronic absorption (emission) spectrum. The first two moments of the absorption and emission spectra are then calculated. The principal utility of this work lies in providing a test case for more approximate theories, although a generalization of the method to three dimensions and to more realistic potentials should also be possible.

539.2 : 535.33

11756 PHONON BROADENING OF IMPURITY LINES.

E.O.Kane.

Phys. Rev., Vol. 119, No. 1, 40-2 (July 1, 1960).

The theory of line broadening given by Lax (Abstr. 2301 of 1955) is found not to apply to shallow impurities in Ge and Si. Observed broadening may be instrumental at low temperatures and may be due to lifetime broadening through phonon interaction at nitrogen temperature. Calculations suggest that p-type spin resonance in germanium and silicon may be observable.

539.2 : 535.33

11757 EFFECT OF AN EXTERNAL ELECTRIC FIELD ON THE PROFILE OF THE FUNDAMENTAL ABSORPTION EDGE OF NONCONDUCTING CRYSTALS.

D.S.Bulyanitsa.

Zh. eksper. teor Fiz., Vol. 38, No. 4, 1201-4 (April, 1960). In Russian.

The problem is solved by employing many-electron wave-functions. The external electric field is taken into account exactly and the Coulomb interaction between electrons and holes is neglected. The absorption coefficient was derived in the neighbourhood of the fundamental absorption edge for all values of the electric field and the frequency of the absorbed light.

539.2 : 535.33

11758 THE EFFECT OF FREE ELECTRONS ON THE OPTICA SELF-ABSORPTION OF CADMIUM OXIDE.

H.Finkenrath.

Z. Phys., Vol. 159, No. 1, 112-24 (1960). In German.

The electrical conductivity, Hall effect and optical absorption in the visible and near ultra-violet were measured for CdO layers prepared by sputtering. The absorption edge shifts to shorter wavelengths with increasing electron concentration, as the Fermi level rises into the conduction band. The extrapolated absorption equation for the classical damped resonator agrees to a factor π with the equation for the absorption by direct band-to-band transitions derived from quantum theory. J.Franks

539.2 : 535.33 : 537.311

ABSORPTION BY Cs—Sb LAYERS. See Abstr. 11709

539.2 : 535.33

11759 SOME OPTICAL MEASUREMENTS ON CALCIUM FLUORIDE.

P.Görlich, H.Karras and K.Kühne.

S.B. Dtsch. Akad. Wiss. Berlin, Kl. Math. Phys. Tech., 1959, No. 2, 3-23. In German.

Measurements of purity, absorption, fluorescence and thermoluminescence were made on synthetic and natural fluorite crystals. Synthetic crystals are free from rare-earth traces but an absorptio at 230 mμ is ascribed to metal ions. Four bands at 580, 482, 398 ar 331 mμ respectively are related to electrons in atomic defects in the lattice. G.F.J.Garlick

539.2 : 535.3

11760 REFLECTANCE OF COAL VITRAINS IN THE VISIBLE AND ULTRA-VIOLET COMPARED WITH THAT OF GRAPHITE.

L.A.Gilbert.

Nature (London), Vol. 186, 143-4 (April 9, 1960).

Reflectance spectra are given for six coal vitrains in the regio 2500 - 6000 A, using a quartz monochromator. Three types of spectra are found. The spectrum of compressed graphite shows a stron peak at 2600 A absent in the coals, although a slight shoulder does not appear between 2600 and 2700 A for the coals. S.Tolansky

539.2 : 535.3

11761 OBSERVATION OF NEW EXCITON LINES IN THE ABSORPTION SPECTRA OF CUPROUS CHLORIDE AT 4.2°K.

R.Reiss and S.Nikitine.

C. R. Acad. Sci. (Paris), Vol. 250, No. 17, 2862-4 (April 25, 1960). In French.

Films of CuCl obtained by vacuum evaporation, show, at 4.2°K new absorption lines in the near ultraviolet. These lines can be classified into two exciton series, one being sharp and the other diffuse. The corresponding reflection spectra has also been studie An explanation of the existence of the two series is suggested.

G.H.C.Freem

539.2 : 535.33

11762 **QUADRUPOLE OPTICAL EXCITATION OF THE FUNDAMENTAL STATE OF EXCITONS IN A CUPROUS XIDE CRYSTAL.** E.F.Gross and A.A.Kaplyanskii.
iz. tverdogo Tela, Vol. 2, No. 2, 379-80 (Feb., 1960). In Russian.

In the study of the spectra of exciton absorption in single rystals of Cu_2O at 77°K, it was found that the absorption of light 6125 A was anisotropic in intensity and in state of polarization epending on crystal orientation. The phenomenon is thus one in hich the cubic system is not optically isotropic, but where the sorption is purely quadrupole in character. A.L.Mackay

539.2 : 535.33

11763 **BRILLOUIN SCATTERING IN ARTIFICIAL QUARTZ GLASS.** W.Geiger and M.Kulp.
Phys. Chem. Solids, Vol. 12, No. 3-4, 341-3 (Feb., 1960). In erman.

An experimental arrangement providing for strong light intensity measure Brillouin splitting of artificial quartz is described. Within e exposure times employed, no Brillouin scattering was found. It shown that according to theory the Brillouin components should ve appeared at exposure times two orders of magnitude less than ose employed. This result is compared with earlier papers on the bject.

539.2 : 535.33

11764 **INFRARED AND LOW-TEMPERATURE ACOUSTIC ABSORPTION IN SYNTHETIC QUARTZ.**
.C.King, D.L.Wood and D.M.Dodd.
hys. Rev. Letters, Vol. 4, No. 10, 500-1 (May 15, 1960).

By growing synthetic quartz from D_2O solution, in order to subtitute OD defects for OH defects, and then observing infrared aborption between 3000 and 4000 cm^{-1}, it is concluded that the absorpon maximum observed in ordinary quartz at 3620 cm^{-1} is due to e OH defect, as suggested by Mitchell and Rigden (Abstr. 8521 of 957), whereas the other absorption bands in this region are not. reatment at high temperature in a static electric field fails to reove this OH defect band, but does remove the 5 Mc/s acoustic aborption at 50°K, suggesting that it and an analagous dielectric rexation loss are also not due to the OH defect. L.Mackinnon

539.2 : 535.33 : 537.311

11765 **ZEEMAN EFFECT OF IMPURITY LEVELS IN SILICON.** S.Zwerdling, K.J.Button and B.Lax.
hys. Rev., Vol. 118, No. 4, 975-86 (May 15, 1960).

Completely resolved Zeeman spectra are presented for the ismuth donor in silicon including optical transitions from the 1s onor ground state to the excited states 2p$_0$, 2p$_\pm$, 3p$_0$, 4p$_0$, 3p$_\pm$, 5p$_0$, p$_\pm$, and 5p$_\pm$. The transitions were observed at liquid helium temerature, using linearly polarized radiation alternately parallel and erpendicular to the magnetic field, and field intensities up to 3.9 kG oriented along each of the three principal crystallographic xes. Both linear splitting of the p$_\pm$ states and a quadratic dependnce on field were observed. The use of impurity Zeeman spectra is emonstrated for evaluating effective mass parameters, determining e nature of energy bands and finding and identifying impurity exted states. The transverse effective mass for the electron in silin was found to be (0.186 ± 0.006) m$_0$ in agreement with recent clotron resonance results. From Zeeman splitting, electron effecte masses up to 0.5 m$_0$ can be measured to within $\pm\frac{1}{2}$% at infrared equencies in a field of 40 kG. The behaviour in a magnetic field of e first two donor excited states could be explained by treating the agnetic terms of the Hamiltonian as a perturbation to first order. teractions among the higher closely-spaced Zeeman levels were served above 20 kG and were evaluated with a second-order treatent. The Zeeman structure for the aluminium acceptor reflected e complexity of the valence bands and the acceptor ground state d was in qualitative agreement with the theoretical results of Kohn d Schecter. Transitions were observed to eight excited states conrging to the series limit. Evidence is given for the degeneracy of ch state.

539.2 : 535.33

11766 **ULTRAVIOLET ABSORPTION IN THALLOUS HALIDES.** S.Tutihasi.
Phys. Chem. Solids, Vol. 12, No. 3-4, 344-8 (Feb., 1960).

The ultraviolet absorption in TlCl and TlBr has been measured thin films and fused samples as a function of temperature. The fect of excessive chlorine or thallium on the optical absorption of Cl has been studied. The experiments of Vysochanskii are discussed in the light of observations made. The first absorption band in TlCl, which peaks at 3.44 eV at −185° C, is absent in films condensed on a cold substrate of KCl and appears after annealing. It seems that the crystal structure of evaporated films of TlCl changes from the NaCl-type to the CsCl-type.

539.2 : 535.33

11767 **INFRARED REFLECTIVITY OF ZINC OXIDE.** R.J.Collins and D.A.Kleinman.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 190-4 (Oct., 1959).

The reflection spectra of single crystals of ZnO were studied between 1 and 45 μ. In samples with free-carrier concentration below 10^{16} cm^{-3}, the usual reflection spectrum of an ionic crystal was observed. An excellent fit to the data is achieved by using a value of the high-frequency dielectric constant $\epsilon_0 = 2.0$, a static dielectric constant $\epsilon_s = 8.15$, and a transverse optical mode frequency $\nu_t = 414$ cm^{-1}. The contribution to the optical constants by the free carriers becomes significant in the reflection spectra for carrier concentrations larger than $\sim 1 \times 10^{17}$ cm^{-3}. Using a method similar to that of Spitzer and Fan an effective mass of $m^* = 0.06$ has been measured. The reflection of ZnO containing carriers can be fitted remarkably well over the range 1-45μ by the classical theory of free carriers and a lattice oscillator. The effective charge per ion site, as defined by Szegetti, is found to be $q^* = 1.06e$.

539.2 : 535.37

11768 **LUMINESCENCE OF IMPURITY CENTRES. I.** A.M.Ratner and G.E.Zil'berman.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1697-706 (Nov., 1959). In Russian.

The wavelength dependences of the absorption coefficient and the intensity of emission are calculated for phosphors containing impurity luminescence centres. Motion of ions is treated classically. Changes in the equilibrium positions of ions occurring on electron transitions, and changes of the elastic constants of the lattice are allowed for. A relationship is deduced between the change of the elastic constants and the deviation of the absorption and luminescence spectra from mutual mirror symmetry and from the Gaussian form. It is shown that the change of the elastic constants can be neglected only when the "law of mirror symmetry" is obeyed. The results obtained are applicable to crystalline, amorphous and liquid phosphors. A.Tybulewicz

539.2 : 535.37

11769 **LUMINESCENCE OF IMPURITY CENTRES. II.** A.M.Ratner.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1707-16 (Nov., 1959). In Russian.

The probability of thermal transitions between impurity-centre levels is calculated. The treatment is similar to that used in Pt I. A relationship is established between the forms of the absorption and luminescence spectra and the probability of thermal transitions. It is shown that, in general, a change of the elastic constants affects strongly the results obtained. A qualitative comparison of the theory with experiment is carried out and the mechanism of energy transfer from the lattice to impurity atoms is discussed for the case of crystals excited with hard radiations. A.Tybulewicz

539.2 : 535.37

11770 **THE EFFECT OF SECONDARY ABSORPTION AND EMISSION PROCESSES ON THE DURATION OF RADIATION EMITTED BY A PLANE-PARALLEL LAYER.** A.M.Samson.
Optika i Spektrosk., Vol. 8, No. 1, 89-97 (Jan., 1960). In Russian.

Deals with the effect of secondary absorption and emission processes on the duration of luminescence or resonance radiation of a plane-parallel layer. Formulae obtained can be used to calculate the required duration under various conditions of irradiation and observation. When the quantum yield is high, the duration may be considerable. The duration observed "by transmission" is always higher than the duration observed "by reflection". A.Tybulewicz

539.2 : 535.37

11771 **EXCITATION OF RECOMBINATION LUMINESCENCE IN THE FUNDAMENTAL ABSORPTION BANDS OF CERTAIN HALIDES.** I.V.Yaék and G.G.Liid'ya.
Optika i Spektrosk., Vol. 8, No. 1, 142-4 (Jan., 1960). In Russian.

Transfer of energy from the base to the activator (in the case of activator luminescence excited in the fundamental absorption band region) in KI:Tl, KI:In, CsI:Tl, RbI:Tl and CdI_2:Pb occurred mainly via recombination of free electrons with holes localized at or near luminescence centres. A.Tybulewicz

539.2 : 535.37

11772 CONTRIBUTION ON THE CONNECTION BETWEEN LIGHT ABSORPTION, DECAY TIME AND ABSOLUTE FLUORESCENCE QUANTUM YIELD IN ORGANIC DYESTUFF MOLECULES. H.Rammensee and V.Zanker.

Z. angew Phys., Vol. 12, No. 5, 237-40 (May, 1960). In German.

Continuing earlier work (Abstr. 7832 of 1958), solutions of a number of acridine derivatives in water at 20°C and in ethanol at 20° and -180°C were measured in respect of their luminescence quantum efficiency, integrated absorption, frequency of absorption band, and mean life of (exponential) decay. These data are interrelated by a constant K (Ladenburg) which should be independent of concentration, temperature and solvent. The results show considerable variation in K, but especially for some compounds known to show association in solution. The variations of K are discussed. S.T.Henderson

539.2 : 535.37

11773 THE SYSTEM $BaO-TiO_2-P_2O_5$: PHASE RELATIONS, FLUORESCENCE, AND PHOSPHOR PREPARATION. D.E.Harrison.

J. Electrochem. Soc., Vol. 107, No. 3, 217-21 (March, 1960).

The subsolidus phase relations were determined in this system using X-ray and petrographic techniques. Four compounds were isolated and individually prepared: $2BaO:TiO_2:P_2O_5$ melts congruently at 1197° ± 3°C; $BaO:TiO_2:P_2O_5$ has a rapidly reversible dimorphic inversion at 967° ± 5°C and it melts congruently at 1428° ± 3°C; $4BaO:3TiO_2:P_2O_5$ melts incongruently at 1302° ± 3°C, and $BaO:4TiO_2:3P_2O_5$ melts incongruently at 1368° ± 3°C. The only compound in the system which is of the self-activated type is $2BaO:TiO_2:P_2O_5$. It has an emission similar to that of $MgWO_4$. Compositions of maximum fluorescence are restricted to the join $2BaO:P_2O_5$-$2BaO:TiO_2:P_2O_5$ since compositions off this join contain either $BaO:TiO_2:P_2O_5$, $4BaO:3TiO_2:P_2O_5$ or TiO_2 which have high u.v. absorption but are nonfluorescent phases.

539.2 : 535.37

11774 MOLECULAR LUMINESCENCE OF BENZENE IN DILUTE SOLUTION IN CYCLOHEXANE AT THE TEMPERATURE OF LIQUID NITROGEN.

C.Courpron, R.Lochet, Y.Meyer and A.Rousset.

C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3095-7 (May 9, 1960). In French.

The luminescence spectra (S → S and T → S) of C_6H_6 and C_6D_6 in cyclohexane at 77°K are discussed and a vibrational interpretation made. G.I.W.Llewelyn

539.2 : 535.37

11775 INFLUENCE OF TEMPERATURE ON THE TWO SERIES OF SPECTRAL BANDS IN THE LOW TEMPERATURE GREEN FLUORESCENCE OF PURE CADMIUM SULPHIDE.

M.Bancie-Grillot, E.F.Gross, E.Grillot and B.S.Razbirine.

C. R. Acad. Sci. (Paris), Vol. 250, No. 17, 2868-70 (April 25, 1960). In French.

Below 20°K cadmium sulphide shows two fluorescent band series each with separations of 300 cm^{-1}. As the temperature is raised one series diminishes in intensity and disappears while the other shows enhancement. The bands are also affected in relative intensity by application of an electric field (~ 1 kV/cm). G.F.J.Garlick

539.2 : 535.37

11776 LUMINESCENCE OF CADMIUM SULPHIDE CRYSTALS. V.V.Eremenko.

Optika i Spektrosk, Vol. 4, No. 3, 348-53 (1958). In Russian. English summary: PB141047 T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The luminescence spectra of monocrystals of cadmium sulphide have been measured at 20°K. The spectrum varies from sample to sample, but usually two regions are observed: a "green" luminescence consisting of a series of bands originating at 19 550 cm^{-1}, and a "blue" luminescence consisting of narrow lines overlapping the absorption spectrum. Usually one region is intense and the other weak. In some samples intense "orange" luminescence is observed. The "green" luminescence is affected by surface treatment. It is concluded that luminescence emission from up to six types of spatially separated centres may be observed, two being responsible for the "green", and four for the "blue" luminescence. J.B.Birks

539.2 : 535.37

11777 FLUORESCENCE MEASUREMENTS ON CYCLOHEXANE MIXED CRYSTALS. D.Griessbach.

Z.Naturforsch., Vol. 15a, No. 4, 296-301 (April, 1960). In German.

At liquid oxygen temperature, solid solutions of naphthalene and several of its mono-, di- and trimethyl derivatives in cyclohexane show sharp line spectra in fluorescence. Frequency differences from these lines agree well with previous work by McClure (Abstr. 180 of 1955) and by Wolf (Abstr. 6910 of 1955). The single 0—0 transition is strong in the methyl derivatives. It is split into two weak components at 31760 and 31700 cm^{-1} in naphthalene, but its combination with the vibration frequency 485 cm^{-1} is permitted, and 31245 cm^{-1} is the strongest line observed in this spectrum. Some lattice frequencies are identified. S.T.Henderson

539.2 : 535.37

11778 SPECTROSCOPIC POLARIZATION MEASUREMENTS ON NAPHTHALENE CRYSTALS. D.Griessbach.

Z. Naturforsch., Vol. 15a, No. 4, 292-6 (April, 1960). In German.

The long-wavelength component of the first 0—0 transition in naphthalene is polarized in the ac-plane. The direction of the transition moment in this plane was determined by photography of polarized fluorescence as 120 ± 20° to the a-axis of the crystal. The effect of light scattering on polarization is discussed, and Wolf's theory of excited states in molecular crystals (Abstr. 3287 of 1959) is found to be somewhat inadequate. S.T.Henderson

539.2 : 535.37 : 621.327.534.15

11779 RELATION OF SOME SURFACE CHEMICAL PROPERTIES OF ZINC SILICATE PHOSPHOR TO ITS BEHAVIOR IN FLUORESCENT LAMPS. D.E.Harrison.

J. Electrochem. Soc., Vol. 107, No. 3, 210-17 (March, 1960).

The importance of the surface properties of zinc silicate phosphor to fluorescent brightness and lumen maintenance has been demonstrated. A phenomenological theory is developed which accounts qualitatively for some of the changes that occur during lamp burning. Inherent in this theory is the concept of a high-temperature surface phase which is a part of the zinc silicate crystal. The surface phase may be retained at room temperature by rapid quenching, but if the phosphor is cooled slowly the surface phase dissociates, probably into its constituent oxides. As a result Mn^{2+} can be oxidized, and Zn^{2+} can be reduced either by vacuum firing or by photolysis by u.v. light. Metallic zinc is produced as a consequence of lamp burning and it amalgamates with mercury. The zinc atoms on the phosphor surface act as vapour traps for mercury and cause it to distribute itself over the surface, probably as tiny droplets. The oxidation of Mn^{2+} and the reduction of Zn^{2+} can be prevented by formation of a protective layer on the phosphor surface, e.g. $ZnSb_2O_6$. It is thought that the surface properties of zinc silicate phosphor, particularly those which affect the extent and perfection of a protective coating, greatly influence the quality of lamps produced by identical procedures.

539.2 : 535.37

11780 INFLUENCE OF TEMPERATURE ON THE SPECTRAL COMPOSITION OF THE ZINC SULPHIDE LUMINESCENCE. I.Soudek.

Brit. J. appl. Phys., Vol. 11, No. 7, 289-92 (July, 1960).

The temperature dependence of the spectral composition has been presented by a new method which shows better the relative changes of the form of the emission band. On the main emission band of some zinc and zinc-cadmium sulphides, between the liquid air temperature and the temperature break-point, certain effects have been observed; these are that (a) below 180°K the short wave side of the emission band of all phosphors grows faster than the long wave side with increasing temperature, (b) that in the neighbourhood of 220°K, the intensity of the whole band has a minimum for all copper-activated and copper-contaminated phosphors, and that (c), above 220°K some phosphors behave inversely as (a). These effects can be explained by the existence of two temperature-dependent processes having inverse influence on the form of the emission band, one being similar to the hole-migration process and the other being in connection with the thermal liberation of trapped electrons.

539.2 : 535.3

11781 ON THE INFRARED EMISSION IN ZnS:Cu — EFFECT OF SULFUR PRESSURE AND ALUMINUM.

E.F.Apple and J.S.Prener.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 81-7 (May, 1960).

The intensity of the infrared emission in ZnS:Cu phosphors has been studied as a function of the sulphur pressure under which the phosphors were heated at high temperatures and of Al concentration in the phosphors. The observed dependence is interpreted using a model in which the infrared absorption and emission arises from hole transitions between states of a normally unionized Cu acceptor and the valence band, and in which sulphur vacancies behave as doubly ionizable donors in ZnS. The effect of Al impurities also follows from the model.

539.2 : 535.37

11782 POLARIZATION OF LUMINESCENCE IN ZnS AND CdS SINGLE CRYSTALS. A.Lempicki.

J. Electrochem. Soc., Vol. 107, No. 5, 404-9 (May, 1960).

The fluorescent emission from hexagonal ZnS and CdS single crystals is found to be polarized preferentially perpendicular to the c axis for both polarized and unpolarized excitation. Cubic ZnS crystals emit unpolarized radiation. The results are analysed in terms of a simple dipole theory which is shown to be inadequate for the description of luminescent centres in these materials. Preliminary observations on the polarization of fluorescence of ZnO crystals are reported.

539.2 : 535.37

11783 POLARIZATION OF FLUORESCENCE IN CdS AND ZnS SINGLE CRYSTALS. J.L.Birman.

J. Electrochem. Soc., Vol. 107, No. 5, 409-17 (May, 1960).

Various symmetry properties of the wurtzite structure are discussed; the band structure of CdS and ZnS at k = 000 is discussed. These symmetry and band structure considerations are used to set up and consider various models, Lambe–Klick, Schoen–Klasens, etc., which would be in accord with observation of polarization. It is concluded that the Lambe–Klick model is the simplest which is in accord with the presently available observations. Some experimental tests are proposed which should help the decision among the various models. In conjuction with other single crystal optical, electrical, and magnetic measurements, polarization studies may prove decisive in obtaining quantitative knowledge about the centres in sulphides.

539.2 : 535.37

11784 EFFECT OF CdS ADDITION IN ZnS:Cu, IN AND ZnS:Ag, IN PHOSPHORS. E.F.Apple.

J.Electrochem. Soc., Vol. 107, No. 5, 418-22 (May, 1960).

ZnS:Cu,In and ZnS:Ag,In phosphors each can show two emission bands under 3650A excitation, namely in the green (short) and orange (long) with Cu and in the blue and yellow with Ag activator. Addition of CdS causes the ratio of intensities of the short to long wavelength emission to increase. This observation is interpreted using the donor-acceptor associated pair model proposed recently for the long wavelength emission process.

539.2 : 535.37

11785 VANADIUM ACTIVATED ZINC AND CADMIUM SULPHIDE AND SELENIDE PHOSPHORS.

M.Avinor and G.Meijer.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 211-15 (Feb., 1960).

Vanadium activated ZnS, ZnSe, CdS and CdSe powders were prepared. All these powders show a fluorescence at about 2 μ. Addition of copper and silver as auxiliary activators enhances the vanadium emission, while the well-known silver and copper emissions do not appear.

539.2 : 535.37

11786 CONTRIBUTION TO THE STUDY OF THE STIMULATION OF PHOSPHORESCENCE BY INFRARED RADIATION]. G.Curie.

Ann. Phys. (Paris),Ser. 13, Vol. 5, No. 3-4, 365-408 (March-April, 1960). In French.

It is shown that the 1.3μ stimulation band for zinc sulphide phosphors is enhanced by lead impurity but exists for non-lead containing specimens. Calcium silicates containing lead and manganese show infrared stimulation, but quenching effects have not been found. The effect of specific infrared irradiation on the thermoluminescence curves for such phosphors is examined and correlation found between infrared stimulation spectra and those representing efficiency of optical emptying of traps. The 1.3μ band is attributed to electron transitions from the valence band to a metastable state of a sulphur ion. G.F.J.Garlick

539.2 : 535.37

11787 LUMINESCENCE SPECTRUM OF $PmCl_3$. J.G.Conway and J.B.Gruber.

J. chem. Phys., Vol. 32, No. 5, 1586-7 (May, 1960).

Crystals of $LaCl_3$ containing small amounts of $Pm^{147}Cl_3$ are self-luminous, and darken rapidly by trapping of the emitted β-rays to form colour centres. Ultra-violet excites increased luminescence especially in the lines near 8300 A. The whole spectrum consists of groups of lines between 4600 and 8300 A. S.T.Henderson

539.2 : 535.37 : 539.1.07

11788 RESPONSE OF NaI(Tl) TO ENERGETIC HEAVY IONS. E.Newman and F.E.Steigert.

Phys. Rev., Vol. 118, No. 6, 1575-8 (June 15, 1960).

The light output of NaI(Tl) was measured as a function of energy for ions of He^4, B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, F^{19}, and Ne^{20} from approximately 1.0 to 10.0 MeV/nucleon. The particle energy was varied with absorbing foils and the degraded beam analysed in a magnetic spectrometer. Light output becomes linear with energy above ~6 MeV/a.m.u. There appears to be an odd–even incident charge effect in the saturation value of the differential efficiency of fluorescence, dL/dE.

539.2 : 535.37

11789 APPARENT LOSS OF EFFICIENCY IN MULTILAYER CATHODOLUMINESCENT FILMS. C.Feldman.

J. Opt. Soc. Amer., Vol. 50, No. 6, 628-9 (June, 1960).

The luminescent brightness of $ZnSiO_4$: Mn films coated with Al (between 0.08 and 90 μ thick) was measured for electron beam energies up to 30 kV. Differences in the brightness against energy characteristics for different Al thicknesses are largely due to electron straggling. J.Franks

539.2 : 535.37 : 621.383.2

11790 ON THE PHYSICAL CHARACTERISTICS AND CHEMICAL COMPOSITION OF ELECTROLUMINESCENT PHOSPHORS. P.Goldberg and S.Faria.

J. Electrochem. Soc., Vol. 107, No. 6, 521-6 (June, 1960).

Through controlled removal of surface layers, it was found that surface chemical barriers are not responsible for electroluminescence in zinc sulphide phosphors. Polycrystalline phosphors are shown to be almost uniform with respect to chemical, physical, and electroluminescent properties as one passes from the surface into the crystallite bulk. Electron micrographs show the character of the particles as successive layers of phosphor surfaces are removed by acid etching. The experimental results at progressive stages of etching are interpreted in terms of an inefficient surface layer and of decreased particle after etching. Regions capable of serving as the site of field intensification are held to exist throughout the volume of the particles.

539.2 : 535.37 : 621.383.2

11791 CaS:Su, Eu ELECTROLUMINESCENT PHOSPHORS. A.Wachtel.

J. Electrochem. Soc., Vol. 107, No. 3, 199-206 (March, 1960).

Introduction of Cu into CaS:Eu does not interfere with the red Eu^{++} emission. Excitation of the blue CaS:Cu emission is more effective by 3650 Å than by 2537 Å. Firing with excess Cu gives rise to deposits of free Cu_2S which may cause an efficient system of contact electroluminescence. The electroluminescent properties depend on the physical characteristics of the phosphors, including its state of agglomeration. At moderate concentrations of Eu, the blue emission of CaS:Cu is entirely suppressed in electroluminescent excitation.

539.2 : 535.37

11792 INVESTIGATION OF ELECTROLUMINESCENCE OF THE SUBLIMATED ZnS:Mn PHOSPHOR.

N.A.Vlasenko and Yu.A.Popkov.

Optika i Spektrosk., Vol. 8, No. 1, 81-8 (Jan., 1960). In Russian.

Pure zinc sulphide and manganese were evaporated simultaneously (from two separate boats) in vacuum onto glass plates and the resultant layers were heat-treated at 500-550°C in order to diffuse Mn into ZnS and to produce good crystal structure. The layers exhibited intrinsic electroluminescence which was a bulk property, and not a surface effect. The intensity of electroluminescence of these layers rose more sharply with the applied field than the intensity of powder phosphors. Shallow (~ 0.1 eV) donor levels were found in the layers.

The ionization energy of these levels depended on the applied voltage, indicating electric field-aided thermal ionization. The electroluminescence spectrum of the layers was a simple band of 0.20 eV half-width with a maximum at 2.13 eV (582 mμ). A.Tybulewicz

539.2 : 535.37 : 621.383.2

11793 ELECTROLUMINESCENCE UNDER PULSED SQUARE WAVE EXCITATION.

R.Zallen, W.T.Eriksen and H.Ahlburg.

J. Electrochem. Soc., Vol. 107, No. 4, 288-95 (June, 1960).

The slow return of an electroluminescent cell to its equilibrium state following a field excitation has been studied for a blue-green emitting Zn(S,O):Cu,Cl phosphor and for a yellow-emitting ZnS:Mn,Cu phosphor. The light pulse emitted upon the rise of a square voltage pulse was measured as a function of repetition rate and of temperature between −130° and 150°C. Relaxation times encountered varied between 10^{-2} and 10^5 sec. The temperature dependence of the relaxation rate exhibits effective activation energies of about 0.4, 0.7, and 0.6 eV, respectively, for the blue, green, and yellow emission bands. The results do not seem to favour the mechanism of delayed recombination. An alternative mechanism is suggested whereby the number of filled deep donors is assumed to control the electroluminescence emission via the number of field-ionizable electrons available for collision-excitation of centres. Observations were also made on some other effects associated with square wave excitation.

539.2 : 535.37 : 621.383.2

11794 THE MECHANISM AND EFFICIENCY OF ELECTROLUMINESCENCE IN ZnS PHOSPHORS. F.F.Morehead, Jr.

J. Electrochem. Soc., Vol. 107, No. 4, 281-7 (June, 1960).

This work describes the application of a model of the electroluminescent process to the photon emission and power consumption of insulated electroluminescent phosphors as a function of voltage and frequency. The model represents an extension of one described earlier. The model leads to a convenient summary of such data and an increased understanding of their significance. An upper limit to the efficiency of impact electroluminescence in insulated particles is proposed on the basis of the implications of the model.

539.2 : 535.37

11795 CORRELATION OF THERMOLUMINESCENCE IN MgO AND VALENCE CHANGES OF IRON AND CHROMIUM IMPURITIES DETECTED BY EPR. R.L.Hansler and W.G.Segelken.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 124-31 (May, 1960).

Electron spin resonance measurements show that during 2537 A irradiation the valence of chromium and iron impurities (~ 10 p.p.m.) in MgO single crystal changes from 2 to 3 or vice versa dependent on treatment. The reverse valence changes as well as thermoluminescence are observed during subsequent heating. It was shown by optical absorption that the energy levels of Fe^{+3} and Cr^{+3} lie about 5.8 and 6.0 eV respectively above the valence band, while the levels of Fe^{+2} and Cr^{+2} are respectively 6.9 and 5.1 below the conduction band. The possible luminescent processes are:

$$Fe^{+3} + \text{free electron} \rightarrow Fe^{+2} + 2.9\ \text{eV};$$
$$Fe^{+2} + \text{free hole} \rightarrow Fe^{+3} + 2.0\ \text{eV};$$
$$Cr^{+3} + \text{free electron} \rightarrow Cr^{+2} + 2.7\ \text{eV};$$
$$Cr^{+2} + \text{free hole} \rightarrow Cr^{+3} + 3.6\ \text{eV}.$$

Four crystals were studied each of which showed preponderantly only one of the above luminescent processes. By assuming the band gap is 8.7 eV, good agreement between the colour of the observed thermoluminescence and that predicted by the model was obtained.

539.2 : 535.37 : 538.27

ELECTRON SPIN RESONANCE AND THERMOLUMINESCENCE IN IRRADIATED FUSED QUARTZ. See Abstr. 10237.

MAGNETIC PROPERTIES OF SOLIDS

539.2 : 538.2

11796 THE STRUCTURE OF MAGNETIC SUBSTANCES. J.Villain.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 303-9 (Oct., 1959). In French.

The paper deals with the prediction of the structure of magnetic materials below the critical point. The molecular field approximation is used; exchange interactions with unlimited range are assumed; the magnetic ions are supposed to form a Bravais lattice. The critical temperature T_c is first calculated without assuming any decomposition of the crystal into sublattices, and the magnetic structure at T_c is given. It is next shown that the essential features of this structure persist below T_c, and the various possible cases are considered. It is possible that no decomposition into sublattices takes place, i.e. the magnetic structure and the nuclear structure have incommensurable periods. Finally, a detailed treatment is given for the body-centred quadratic lattice with interaction between first, second and third neighbours.

539.2 : 538.2

11797 THE DIAMAGNETISM OF CONDUCTION ELECTRONS IN METALS. J.E.Hebborn and E.H.Sondheimer.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 105-23 (May, 1960).

The partition function is calculated to order H^2 for a gas of independent electrons interacting with a periodic lattice potential and a uniform applied magnetic field H. A formula is deduced for the steady diamagnetic susceptibility of a metal, expressed in terms of the Bloch wave-functions and energy levels. The result is exact and general within the limits of the Bloch model.

539.2 : 538.2

11798 METAMAGNETIC BEHAVIOR OF MANGANESE ARSENIDE. D.S.Rodbell and P.E.Lawrence.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 275S-276S (May, 1960).

Between 35° and 125° C there exists a threshold magnetic field strength at which the compound MnAs exhibits a large and steep increase of its net magnetization. At 35° C the threshold field is 40 kOe. There is a large hysteresis associated with the magnetization change. This behaviour resembles that exhibited by a material that is metamagnetic in the sense of Néel's description. It is believed, however, that in this material the existence of a first-order phase transformation is sufficient to account for the magnetic behaviour.

539.2 : 538.2

11799 MAGNETIC TRANSITIONS IN Ti_2O_3 AND V_2O_3. P.H.Carr and S.Foner.

J. appl. Phys., Suppl to Vol. 31, No. 5, 344S-345S (May, 1960).

The principal susceptibilities of single crystals of Ti_2O_3 and V_2O_3 have been measured from 4.2°K to 300°K by means of a vibrating sample magnetometer. In Ti_2O_3, $\chi_\parallel = 9 \times 10^{-7}$ cgs/g and $\chi_\perp = 8 \times 10^{-7}$ cgs/g, and both susceptibilities are nearly temperature independent. In V_2O_3, below the transition temperature T_0, $\chi_\parallel = 6.9 \times 10^{-6}$ cgs/g and $\chi_\perp = 5.9 \times 10^{-6}$ cgs/g and both are temperature independent. The small, almost equal, and temperature independent values of both $\chi_\parallel$ and $\chi_\perp$ below T_0 confirm recent neutron diffraction data which indicate no appreciable long-range antiferromagnetic order for these oxides. Van Vleck temperature independent paramagnetism can account for the observed values. It is concluded that the observed discontinuities of susceptibility and corresponding electrical conductivity changes are not due to long-range magnetic ordering effects.

539.2 : 538.2

11800 PRECISE MEASUREMENT OF MAGNETIC-FORM FACTORS. R.Nathans.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 350S-351S (May, 1960).

A brief outline of the application of the polarized beam techniqu to studies of the magnetic-form factor is given. Limitations on the accuracy of the final data imposed by corrective factors are noted. A summary of the main results of the measurements taken to date and a discussion of the proposed investigations are presented.

539 2 : 538.2

11801 EFFECT OF CRYSTALLINE FIELDS ON MAGNETIC-FORM FACTORS. A.J.Freeman and R.E.Watson.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 374S-375S (May, 1960).

The effects of crystalline fields on magnetic-form factors are discussed on the basis of recent Hartree–Fock calculations of Watson augmented by an analysis of experimental optical absorption data. It is shown that the crystalline field has two effects on the fre ion 3d wavefunctions and hence on their form factors as well: (1) a differentiation of "splitting" of the two types of cubic 3d functions by an expansion of the t_{2g} (or e_g) orbital and a contraction of the e_g (or t_{2g}) orbital resulting in two different radial charge densities and (2) a net expansion of the charge distribution from the fre on value. The magnetic-form factor due to this "splitting" effect when calculated according to the method of Weiss and Freeman shows measurable deviations from the free atom results. A form factor for Mn^{+2} based on optical absorption data shows a large expansion of he 3d charge density, in agreement with the measurements of Hastings, Elliott, and Corliss.

539.2 : 538.2

11802 MAGNETIZATION FLUCTUATIONS AND CRITICAL OPALESCENCE. P.G.de Gennes and J.Villain.
J. Phys. Chem. Solids, Vol. 13, No. 1-2, 10-27 (May, 1960).
In French.

This paper deals with fluctuations in magnetization in substances in which several types of magnetic ions are present simultaneously. First, by means of a localized form of the molecular field approximation, the intensity of fluctuations corresponding to each wave vector is studied. It is shown, in particular, that the results obtained below the transition temperature agree exactly at low temperatures with the rigorous formulae deduced from the theory of spin waves. Next, the relaxation of fluctuations in the paramagnetic range is considered, particularly the phenomena of "slow relaxation". Critical opalescence phenomena are found, but they show important differences in behaviour from what is known from the simple situations considered up to now. Some of these anomalies may be observed in neutron-scattering experiments. These effects are worked out numerically for magnetite, where six non-equivalent sublattices have to be considered. It is also shown that for antiferromagnets the reaxation of the critical fluctuations is slow, and, that their frequency spectrum is of the Lorentz type. This is a thermodynamic effect and is distinct from the spin diffusion effect familiar in ferromagnets.

539.2 : 538.2

11803 A NOTE ON THE MAGNETIC SUSCEPTIBILITY OF SEMI-CONDUCTING COMPOUNDS OF $A^{III}B^{V}$. M.Matyáš.
Czech. J. Phys., Vol. 9, No. 2, 257-8 (1959).

An empirical formula for the lattice contribution to the magnetic susceptibility of $A^{III}B^{V}$ compounds, based on the experimental values for InP, InAs, InSb and GaP, GaAs, and GaSb is derived.

A.J.Manuel

539.2 : 538.2

11804 AN INVESTIGATION OF THE QUANTIZED OSCILLATIONS IN THE MAGNETIC SUSCEPTIBILITY OF BISMUTH AT EXTREMELY LOW TEMPERATURES.
N.B.Brandt, A.E.Dubrovskaya and G.A.Kytin.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 572-5 (Aug., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 405-7 (Feb., 1960).

Measuring the susceptibility at temperatures between 0.06° and 0.1° K shows additional high frequency oscillations superposed on the ones usually observed. These correspond to a group of holes which have a Fermi surface in the form of a surface of revolution stretched out along the trigonal axis. The concentration is $\sim 0.5 \times 10^{18}$ cm^{-3} and the effective mass $\cong 0.06\ m_0$.

D.J.Oliver

539.2 : 538.2

11805 MAGNETIC PROPERTIES OF Cr_2O_3—Al_2O_3 CATALYSTS. A.M.Rubinshtein and A.A.Slinkin.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1386-9 (April 21, 1960).
In Russian.

The susceptibility, Weiss constant and magnetic moment of fresh and worked Cr_2O_3—Al_2O_3 catalysts are determined as a function of Cr_2O_3 content and calcining temperature. The results are interpreted in terms of the phase constitution and the content of Cr^{3+} and Cr^{6+} ions. The magnetic properties of Cr_2O_3—SiO_2 catalysts are also briefly discussed.

R.F.S.Hearmon

539.2 : 538.2

11806 ON THE MAGNETIC PROPERTIES OF CUBIC CERIUM. T.Murao and T.Matsubara.
Progr. theor. Phys., Vol. 18, No. 3, 215-22 (Sept., 1957).

In terms of the level splitting of the electronic state $4f^1(^2F_{5/2})$ due to the crystalline and exchange field, the magnetic susceptibility and specific heat of cubic cerium are calculated theoretically and compared with experiment. The intensity of the crystalline field is also estimated using a simplified model of the metallic state. The agreement between theory and observation is fairly good.

539.2 : 538.2

11807 THE MAGNETIC PROPERTIES OF THE PRASEODYMIUM AND THE NEODYMIUM METALS. T.Murao.
Progr. theor. Phys., Vol. 20, No. 3, 277-86 (Sept., 1958).

Along the same lines as the previous discussion of cubic cerium metal (see preceding abstract), the magnetic properties of the succeeding rare earth metals, praseodymium and neodymium, are investigated. Because these metals have h.c.p. structure, their crystalline field potentials cannot be uniquely determined so as to fit the experimental data. The analysis is, however, qualitatively satisfactory.

539.2 : 538.2

11808 MAGNETIC SUSCEPTIBILITY OF METALLIC EUROPIUM. R.M.Bozorth and J.H.Van Vleck.
Phys. Rev., Vol. 118, No. 6, 1493-8 (June 15, 1960).

The susceptibility was measured from 1.3 to 300° K in fields up to 12 000 Oe. The metal was found not to be ferromagnetic, but to have at low temperatures a very high paramagnetic susceptibility, ~ 40 times higher than for the free ion or hydrated salts. Variation of susceptibility with field strength was observed below 100° K. The saturation curvature at low temperatures is very large, and practically independent of temperature. The susceptibility at high temperatures is consistent with a divalent model. The magnetic behaviour at low temperatures is hard to interpret on the basis of a divalent ion and can be more readily explained with a trivalent one for which the theory is developed. Metallurgical evidence, however, indicates that metallic europium is divalent even at low temperatures. On the other hand, it is generally believed that europium is trivalent in $EuIr_2$, but if one uses the conventional molecular field theory the reported ferromagnetism of $EuIr_2$ cannot be ascribed to Eu^{3+} with a value of the exchange field consistent with that in $GdIr_2$.

539.2 : 538.2

11809 PARAMAGNETIC SUSCEPTIBILITIES OF Fe AND Fe—Si ALLOYS. S.Arajs and D.S.Miller.
J. appl. Phys., Vol. 31, No. 6, 986-91 (June, 1960).

Paramagnetic susceptibilities of Fe and Fe—Si alloys (5.75, 6.82, 9.45, 12.65, 14.70, 18.11, 20.85, and 24.38 at. % Si) have been measured up to 1200°C. At high temperatures the paramagnetic susceptibilities of b.c.c. Fe—Si alloys obey the Curie—Weiss law, possibly indicating that the contribution due to s—d exchange interactions is small in comparison with the temperature dependent paramagnetism. The effective Bohr-magneton number of Fe from the high-temperature region is independent of Si content up to about 14 at. % Si. At higher Si concentrations, gradual decrease in the effective Bohr-magneton number occurs. According to the paramagnetic susceptibility measurements, the $\alpha-\gamma$ transition in iron takes place at 910 ± 3°C. Assuming that the critical temperatures for chemical ordering as given by Glaser and Ivanick are correct, the measurements indicate that the paramagnetic susceptibility, within the experimental error, is not influenced by the destruction of the superlattice above 13 at. % of Si.

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11810 MAGNETIC BEHAVIOR OF POLYCRYSTALLINE NEODYMIUM, HOLMIUM, AND ERBIUM FROM 300 TO 1500° K. S.Arajs and D.S.Miller.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 325S-326S (May, 1960).

The paramagnetic susceptibilities of polycrystalline Nd, Ho, and Er have been determined from about 300 to 1500° K by the Faraday method. The inverse paramagnetic susceptibility versus temperature (χ^{-1} versus T) curve for Nd at high temperatures show two slight anomalies associated with a solid state phase transformation and the melting point, respectively. The paramagnetic susceptibility of h.c.p. Nd does not satisfy the Weiss—Curie law due to the partial population of the energy levels above the ground state $^4I_{9/2}$. The paramagnetic susceptibility of Ho and Er is representable by the Weiss—Curie law. The experimental Bohr magneton numbers are in satisfactory agreement with those predicted by the Van Vleck theory.

539.2 : 538.2

11811 MAGNETIC PROPERTIES OF THULIUM METAL. D.D.Davis and R.M.Bozorth.
Phys. Rev., Vol. 118, No. 6, 1543-5 (June 15, 1960).

Measurements made from 1.3° to 300° K, in fields up to 12 000 Oe, show that thulium becomes antiferromagnetic on cooling to 60° K and is ferromagnetic below 22° K. In agreement with earlier work the susceptibility between 70° and 300° K obeys the Curie—Weiss law and the effective Bohr magneton number is 7.6, equal to the theoretical value for the trivalent ion core having two holes in the 4f shell. The highest observed ferromagnetic moment is only 0.5 Bohr magneton whereas the theoretical value is gJ = 7. Large hysteresis and crystal anisotropy are observed at the lowest temperatures. It is suggested that the anisotropy is so large that the magnetization cannot be deviated appreciably from the hexagonal axis even in the higher fields (70 000 Oe) used by Henry; he observed 3.4 Bohr magnetons whereas the highest expected for polycrystalline material on this assumption is 3.5.

539.2 : 538.2

11812 THE APPROACH TO FERROMAGNETIC SATURATION. I. GENERAL THEORY OF THE EFFECT OF INTERNAL STRESSES ON THE [SATURATION] APPROACH LAW WITH APPLICATION TO INTERSTITIAL ATOMS AND QUENCHED METALS.

A.Seeger and H.Kronmüller.

J. Phys. Chem. Solids, Vol. 12, No. 3-4, 298-313 (Feb., 1960). In German.

The differential susceptibility of ferromagnetic materials is calculated in the region of the approach to saturation. The internal stresses are assumed to be known through the dislocation density or the distribution of incompatibilities. An explicit knowledge of the stress field is not required, however. The theory contains a characteristic length that depends on the magnetic field H and that in typical cases is of the order of magnitude of 100 A. Internal stress fields that vary over such distances affect the susceptibility rather strongly and may be studied by measurements of the approach to saturation. The present paper treats dislocation rings of the type found in quenched metals, and interstitial atoms. The application to deformed metals will be given in Pt II.

539.2 : 538.2

11813 THEORY OF THE STABILITY OF MAGNETIC STATES OF FERROMAGNETIC MATERIALS IN THE MAGNETIZATION PROCESS.

E.I.Kondorskii

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1110-15 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 790-3 (April, 1960).

The physical principles that determine the stability of magnetic states of a ferromagnetic monocrystal, with respect to external magnetic fields and to elastic forces, are considered. A formula is derived for the minimum value of magnetic fields and stresses at which the equilibrium of a domain wall passing near a nonmagnetic inclusion is destroyed, and at which an irreversible change of magnetization occurs. On this basis an explanation is given for the phenomenon, familiar experimentally, of strong magnetization of ferromagnets in weak magnetic fields by shocks or blows, and formulae are derived for estimating the irreversible changes of magnetization produced by elastic stresses. An explanation is given for the observed stability, with respect to elastic forces, of magnetic states corresponding to the ideal magnetization curve.

539.2 : 538.2

11814 COMBINATORIAL ASPECTS OF THE ISING MODEL FOR FERROMAGNETISM. I. A CONJECTURE OF FEYNMAN ON PATHS AND GRAPHS.

S.Sherman.

J. math. Phys. (New York), Vol. 1, No. 3, 202-17 (May-June, 1960).

An identity on paths in planar graphs conjectured by Feynman is rigorously established. This permits a complete analysis of the combinatorial approach to the two-dimensional Ising model with nearest neighbour interaction and 0 external magnetic field previously heuristically discussed by Kac and Ward (Abstr. 2811 of 1953) and Potts and Ward (Abstr. 10065 of 1955). Relevant identities are established for the two-dimensional Ising model with next nearest neighbour interactions and 0 external magnetic field, for the two-dimensional Ising model with nearest neighbour interactions and positive external magnetic field, and for the three-dimensional Ising model with nearest neighbour interactions and 0 external field. For the case of a square net with an odd number of spin locations with nearest neighbour interactions and external field equal to $i\pi/2$, it is shown that the partition function is identically zero for both plane and torus imbedding contrary to a result announced by Lee and Yang [Abstr. 7247 of 1952; Eq. (48)], which turns out to be correct only for an even number of spin locations.

539.2 : 538.2

11815 CLUSTER SUMS AND RELATED COEFFICIENTS OF THE ISING MODEL.

S.Katsura.

Progr. theor. Phys., Vol. 20, No. 2, 192-215 (Aug., 1958).

Discusses the intuitive meaning and the interrelations of various coefficients of the Ising model of ferromagnetision. Thus, the intuitive meaning of b_{lm} and $\bar{b}_{lm}$, the coefficients of cluster sums, is explained. Van der Waerden—Oguchi's expansion is generalized to the case with magnetic field and the coefficient Ω_{nm} is defined and its meaning is explained. The equivalence of the calculation of the susceptibility with zero field and the non-crossing chain problem is proved. A method of evaluating these coefficients is proposed which requires least labour of counting the graphs by using the decomposition of Fuchs' coefficients γ_k. Applications to the theory of the imperfect gases are discussed.

539.2 : 538.2

11816 THE SUSCEPTIBILITY OF THE PLANE ISING MODEL.

M.E.Fisher.

Physica, Vol. 25, No. 7, 521-4 (July, 1959).

Using Kaufman and Onsager's work on correlation functions (Abstr. 2773 of 1950) the authors establish the asymptotic behaviour of the susceptibility $\chi_o(T)$ in the region of critical temperature, T_c. The ferromagnetic susceptibility (J>O) becomes infinite as $T \rightarrow T_c$, according to $\chi_F(T) \approx N\mu^2 C/kT(1-T_c/T)^{7/4}$, where C is constant and μ the magnetic moment per spin. J.H.Mason

539.2 : 538.2 : 519

EXCLUDED-VOLUME PROBLEM AND THE ISING MODEL OF FERROMAGNETISM.

See Abstr. 10468

539.2 : 538.2

11817 SURFACE MAGNETOSTATIC MODES AND SURFACE SPIN WAVES.

J.R.Eshbach and R.W.Damon.

Phys. Rev., Vol. 118, No. 5, 1208-10 (June 1, 1960).

Examination of the spatial configuration of the magnetostatic modes of a ferromagnetic body shows that those modes whose frequency lies between $\omega = \gamma(B_i H_i)^{1/2}$ and $\omega = \gamma(H_i + 2\pi M)$ are surface modes. It is also found that the complete spin-wave spectrum consists of a set of surface spin waves in addition to the spin-wave band usually considered. The magnetostatic mode spectrum thus merges smoothly into the spin-wave spectrum. The characteristic equation for the surface modes on a plane surface at an arbitrary angle to the applied d.c. field is given. The properties of the surface modes on plane surfaces and on spheroidal bodies are discussed.

539.2 : 538.2

11818 REMARKS ON SPIN-WAVE THEORY FOR THE FERROMAGNETIC EXCHANGE PROBLEM.

I.Mannari.

Progr. theor. Phys., Vol. 19, No. 2, 201-13 (Feb., 1958).

A theory which is essentially equivalent to the Bloch—Bethe—Van Kranendonk formalism (Abstr. 3818-19 of 1956) is developed for the properties of an ideal ferromagnet with isotropic exchange coupling between nearest-neighbour spins $\frac{1}{2}$. A complete treatment is given of the thermodynamic properties of the system at low temperatures far below the Curie point. In this temperature region, the excitation of the system is naturally described in terms of spin waves which obey Fermi—Dirac statistics. Interactions between spin waves are discussed in the scheme of the second quantization, and their effects on the spontaneous magnetization are also discussed.

539.2 : 538.2

11819 LONG-RANGE MAGNETIC INTERACTIONS VIA CONDUCTION ELECTRONS.

A.Paskin.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 318S-319S (May, 1960).

Yosida has shown that the long-range ferromagnetic term, arising from the exchange interaction between conduction electrons and unfilled inner-shell electrons, does not appear explicitly when the calculation is extended to second-order perturbation (i.e. the magnetic interaction term to second-order perturbation is not long-range but decreases rapidly with distance). The author finds, on re-examining the Yosida calculation, that the long-range magnetic term disappears because of noninteracting electron approximations made for the energy and density of states of the conduction electrons. Without the latter approximation but still to second-order, the long-range magnetic interaction appears with a coefficient proportional to $[(\partial^2 E/\partial n^2)^{-1} - \rho(E_f)]$ where $\rho(E_f)$ is the density of states evaluated at the Fermi energy; n the number of conduction electrons of a given spin; and E their energy. This coefficient can be estimated both from theoretical calculations of Pines on electron interaction effects in metals as well as from nuclear magnetic resonance data. From the calculations of Pines, it is concluded that the coefficient is such that the ong-range magnetic interaction may not be neglected. Using nuclear agnetic resonance data, it is estimated that the magnitude of the ong-range term and the short-range interaction term are the same r the Cu—Mn alloys studied by Yosida.

539.2 : 538.2

11820 THE [MAGNETIC] SYMMETRY OF FERROMAGNETICS AND ANTIFERROMAGNETICS. B.A.Tavger.

ristallografiya, Vol. 3, No. 3, 339-41 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 3, 341-3 (May-June, 1958).

The classes of magnetic symmetry admitting spontaneous macro-copic magnetization are derived. The phenomenon of weak ferro-agnetism of antiferromagnetics is discussed from the point of iew of magnetic symmetry.

539.2 : 538.2

11821 NONRESONANCE ABSORPTION OF THE ENERGY OF A VARIABLE MAGNETIC FIELD BY A FERROMAGNETIC IELECTRIC. II.

.I.Kaganov and V.M.Tsukernik.
h. eksper. teor. Fiz., Vol. 38, No. 4, 1320-5 (April, 1960). In ussian.

For Pt I, see Abstr. 10170 of 1960. The imaginary part of the ransverse magnetic susceptibility of a ferromagnetic dielectric is omputed using the spin-wave theory.

539.2 : 538.2 : 621.318.122

11822 VARIATION OF PERMANENT-MAGNET PROPERTIES WITH CRYSTAL ORIENTATION IN COLUMNAR RYSTAL ALLOYS. M.McCaig and W.Wright.

rit. J. appl. Phys., Vol. 11, No. 7, 279-81 (July, 1960).

The crystal orientations of three casts of a columnar permanent-agnet alloy have been compared. The same alloy has also been cut nd tested at various angles to the columnar axis. Coercivity and BH)$_{max}$ fall off less rapidly with angle than is predicted by Stoner nd Wohlfarth, but may agree better with more modern theories, ome of which have not yet been worked out in a form suitable for omparison. It is concluded that variations in the properties of olumnar permanent-magnet alloys are still not wholly accounted r, although spread of crystal orientation may be a contributory actor.

539.2 : 538.2 : 548.7

11823 MAGNETIC MOMENTS OF ALLOYS OF GADOLINIUM WITH SOME OF THE TRANSITION ELEMENTS.

V.M.Hubbard, E.Adams and J.V.Gilfrich.
. appl. Phys., Suppl. to Vol. 31, No. 5, 368S-369S (May, 1960).

Alloys of gadolinium with some of the transition elements were repared and examined by X-ray and magnetic techniques in an ffort to determine their structure, Curie temperatures and agnetic moments. Values obtained for the saturation magnetizaion for some compositions in the gadolinium—cobalt system were igher than those reported by Nesbitt et al., but the data agree ualitatively with their theory of an antiferromagnetic interaction. n increase in saturation magnetization at room temperature and elow was noted for some compositions that were cooled from their urie points in a magnetic field. An extremely high intrinsic oercive force ($_IH_c$ = 8000) was measured on the powdered hexaonal compound GdCo$_5$ indicating a high anisotropy for this strucure. The lattice parameters for a face centred cubic and two exagonal phases in this system were calculated from the X-ray ata. The structure of the gadolinium—manganese system was ound to be extremely complex, and only the compound GdMn$_2$ was dentified. Magnetic moment versus temperature values were also etermined for various compositions. The Curie temperature for he composition Gd$_{0.2}$Mn$_{0.8}$ was found to be approximately 250°C.

539.2 : 538.2

11824 MAGNETO STRUCTURAL STUDIES ON GADOLINIUM-IRON ALLOYS.

.C.Vickery, W.C.Sexton, V.Novy and E.V.Kleber.
. appl. Phys., Suppl. to Vol. 31, No. 5, 366S-367S (May, 1960).

Magnetic and constitutional data have been established for a eries of alloys in the gadolinium-iron system, ranging from -98% Fe. Seven intermetallic compounds have been found and ome correlation has been derived between their crystal structures nd magnetic properties. The cubic Gd$_2$Fe$_3$ compound has been ound to exhibit highest magnetization values of the intermetallics and comparison of data on the Gd—Co and Gd—Ni compounds suggests that presence of the 2 : 3 structure (not found in the Gd—Ni system) is necessary for the development of ferromagnetism in these systems.

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11825 GeFeO$_3$: A FERROMAGNETIC-PIEZOELECTRIC COMPOUND. · J.P.Remeika.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 263S-264S (May, 1960).

Piezoelectricity and ferromagnetism have been found to occur simultaneously in the compound Ga$_{(2-x)}$Fe$_x$O$_3$. Single crystals of approximately equimolar gallium to iron ratio have been grown from a flux consisting of Bi$_2$O$_3$ and B$_2$O$_3$. X-ray diffraction data on ceramic compositions have shown that the gallium to iron ratio can be varied between x = 0.7 to x = 1.4. Magnetic data showing the shift in magnetic Curie point versus Fe concentration and magnetization versus Fe concentration will be given.

539.2 : 538.2 : 539.14

11826 MEASUREMENT OF LOCAL FIELDS AT IMPURITY Fe^{57} ATOMS USING THE MÖSSBAUER EFFECT.

G.K.Wertheim.
Phys. Rev. Letters, Vol. 4, No. 8, 403-5 (April 15, 1960).

Local magnetic fields at Fe^{57} nuclei in Fe, Co, Ni and n-type silicon are investigated, using these as sources. Stainless steel and diamagnetic potassium ferrocyanide, which exhibit unsplit absorption lines, are used as absorbers. Values of the local magnetic fields, in oersteds, are found to be 3.3×10^5, 3.1×10^5, and 2.6×10^5 in Fe, Co, and Ni, respectively, and 3×10^4 for an iron atom occupying a site characteristic of a cobalt atom in silicon.

E.A.Sanderson

539.2 : 538.2 : 539.14

11827 DIRECTION OF THE EFFECTIVE MAGNETIC FIELD AT THE NUCLEUS IN FERROMAGNETIC IRON.

S.S.Hanna, J.Heberle, G.J.Perlow, R.S.Preston and D.H.Vincent.
Phys. Rev. Letters, Vol. 4, No. 10, 513-15 (May 15, 1960).

By observing the change in the hyperfine splitting of the nuclear energy levels, using the Mössbauer effect, the effective magnetic field at the iron nucleus is found to be antiparallel to the direction of magnetization.

E.A.Sanderson

539.2 : 538.2

11828 MAGNETIC-FORM FACTOR OF Fe$_3$Al.

S.J.Pickart and R.Nathans.
J. appl. Phys., Suppl. to Vol. 31, No.5, 372S-373S (May, 1960).

A polarized neutron study carried out on the high-angle superlattice reflections of ordered Fe$_3$Al shows that the near neighbour environment influences not only the average moment per Fe atom, but also the spatial symmetry of the d electron charge distribution. Preliminary analysis of the form factor indicates that the magnetic electrons of the Fe atom surrounded by 8 Fe near neighbours (which has a moment $\mu = 2.1\mu_B$) preferentially occupy the doubly degenerate e$_g$ orbitals, while those of the Fe atom with 4 Fe and 4 Al near neighbours ($\mu = 1.5\mu_B$) favour the triply degenerate t_{2g} orbitals.

539.2 : 538.2

11829 MAGNETIC PROPERTIES OF SOLID SOLUTIONS OF Fe$_3$O$_4$ AND Fe Al$_2$O$_4$. S.J.Pickart and A.C.Turnock.

J. Phys. Chem. Solids, Vol. 10, No. 2-3, 242-4 (July, 1959).

The moment of aluminium substituted magnetite has previously been found to follow $\mu = 4 - 3x$, where x is the number of Al^{3+}. The limiting substitution was 20 mol % but it has now been possible to synthesize any composition in the range $0 \leq x \leq 2$. Magnetic measurements, including Curie point determinations, have been made on a series within this range. For x = 0.73 and 1.14 the magnetization increases initially with temperature. The moments (T = 0°K) follows the law above as far as x = 0.6 in the quenched samples used. This relation is not what would be expected according to Verwey's rules, i.e. Al^{3+} replacing Fe^{3+} on the B sites of the spinel lattice. It is possible that a transition from the inverse to the normal spinel arrangement is occurring as the substitution progresses and the observations are not inconsistent with this.

F.G.Hoare

539.2 : 538.2

11830 INTERPRETATION OF THE MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF SEVERAL IRON, NICKEL, AND IRON-NICKEL NITRIDES.

J.B.Goodenough, A.Wold and R.J.Arnott.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 342S-343S (May, 1960).

The saturation moment at 4°K and the room-temperature structure of the following nitrides have been examined: $Fe_{4-x}Ni_xN$ with $0 \leq x \leq 3$ (Fe_4N-type structure); tetragonal, ordered FeNiN; hexagonal $Fe_{3-y}N$ with $0 < y < 1$; hexagonal $Ni_3N_{1.16}$; and orthorhombic Fe_2N. The atomic ordering, nitrogen solubility, and atomic moments of the system $Fe_{4-x}Ni_xN$ are interpreted from a model of the band structure of the f.c.c. transition elements of the first long period in which it is explicitly assumed that the crystalline fields split the d bands into separable components.

539.2 : 538.2 : 548.7

FERROMAGNETIC-ALLOY PHASES NEAR THE COMPOSITIONS Ni_2MnIn, Ni_2MnGa, Co_2MnGa, Pd_2MnSb, AND PdMnSb.
See Abstr. 12048

539.2 : 538.2 : 537.3

TRANSVERSE EFFECTS IN IRON–SILICON SINGLE CRYSTALS.
See Abstr. 11666

539.2 : 538.2

11831 CHANGE OF ATOMIC MAGNETIC MOMENTS OF FERROMAGNETIC METALS UNDER UNIFORM COMPRESSION.
E.I.Kondorskii and V.L.Sedov.
Zh. eksper. teor. Fiz., Vol. 38, No. 3, 773-9 (March, 1960).
In Russian.

An investigation was carried out on the variation of the magnetic moments σ and the electrical resistance R during uniform compression of iron, nickel and iron–nickel alloys containing 34% or more nickel and also of nickel–copper alloys containing up to 48% of copper. The investigation was carried out at helium and hydrogen temperatures in magnetic fields up to 8600 Oe. The dependence of σ and R on pressure is approximately an order higher in iron–nickel alloys containing from 34 to 45% of nickel (Invar alloys) than in other investigated alloys and metals. In all investigated metals and alloys the magnetic moment decreased under uniform pressure. Uniform pressure led to a decrease of the electrical resistance in nickel and iron and to an increase in the Invar alloys. A possible explanation of the observed variations of σ and R is considered and it is noted that the comparatively large changes of these quantities under the influence of pressure and other peculiarities of Invar alloys can be explained by the existence of a "latent" antiferromagnetism which is the result of the negative sign of the exchange integral of iron in the face-centred lattice.

539.2 : 538.2

11832 MAGNETIC PROPERTIES OF THE $Li_xMn_{1-x}Se$ SYSTEM. T.R.McGuire and R.R.Heikes.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 276S-277S (May, 1960).

The details of the magnetic behaviour of the $Li_xMn_{1-x}Se$ system are attributed to the double exchange interaction. At low temperatures, the hole, which is introduced by the Li^+, is bound to the Li^+ itself. Double exchange causes local distortions of the spin system. As the concentration is increased (x = 0.07), these local distortions overlap sufficiently so that a magnetic field will induce a suitable moment. Finally at x = 0.10 one finds that spontaneous magnetization develops below 110° K. As the temperature is lowered through 70° K, the spontaneous moment disappears and an antiferromagnetic state is found. This phase change is attributed to the binding of the holes to the Li^+.

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11833 ANALYSIS OF MAGNETIC INTERACTIONS IN ALLOYS OF PLATINUM WITH IRON GROUP TRANSITION ELEMENTS. H.Sato.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 327S-329S (May, 1960).

The magnetic properties of alloys of platinum with iron group transition elements are analysed and interpreted on the basis of an Ising model of ferromagnetism. It is found that in the wide ranges of compositions of the face-centred-cubic alloys of Ni, Co, Fe, Mn, and Cr with Pt there is systematic change with atomic number in the dependence of Curie temperature and saturation magnetization on concentration of magnetic atoms or on the formation of superlattices. Values of magnetic interactions in alloys, which also depend on the concentration, are estimated mainly from the Curie point by using the cluster-variation method. The magnetic moment of Pt atoms can be induced in alloys and this tendency becomes stronger as the d-shell radii of magnetic atoms increase. The analysis also indicates that the magnetic interactions of γ-Fe, γ-Mn and f.c.c. Cr change their signs from negative to positive by merely increasing the interatomic distance. This is most clearly shown in the case of γ-Fe. Further, it is suggested that the alloys Mn–Pt and Cr–Pt would show ferrimagnetic behaviour as found in disordered Ni–Mn alloys. Based upon such analyses, a qualitative conclusion concerning the dependence of magnetic interactions upon distance is drawn. The general behaviour of the interaction is consistent with the generally accepted picture of the location of these elements with respect to the "Bethe–Slater curve" of exchange interactions if the distances are short, but not if the distances are longer.

539.2 : 538.2

11834 MAGNETIC PROPERTIES OF URANIUM DIGERMANIDE. C.E.Olsen.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 340S-341S (May, 1960).

Investigations on the magnetic properties of actinide element intermetallic compounds has disclosed that UG_2 and $PuGe_2$ are ferromagnetic with magnetic moments greater than 0.803 and 0.144 Bohr magneton per molecule respectively at 4° K. Electrical resistivity measurements on UGe_2 indicate an interaction of the conduction electrons with the local spin which produces ferromagnetism. Also the electrical resistivity of USi_2, which is not ferromagnetic, was measured for comparison.

539.2 : 538.2

11835 EFFECT OF IMPURITIES ON THE LOW-TEMPERATURE SPONTANEOUS MAGNETIZATION OF CUBIC FERROMAGNETIC CRYSTALS. A.A.Maradudin and P.A.Dixon.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 329S-331S (May, 1960).

The effect of substitutional impurities on the low temperature spontaneous magnetization of cubic ferromagnetic crystals is investigated in the spin wave formalism with the aid of techniques developed previously for the study of defect problems in lattice dynamics. The impurities considered have an exchange integral with their nearest neighbours different from that between neighbours in the pure crystal. The results of these calculations show that the Bloch $T^{3/2}$ law is still obeyed, but that the coefficient of the $T^{3/2}$ term is a function of the impurity concentration whose form is determined in the limit of low impurity content.

539.2 : 538.2

11836 THE THEORY OF THE TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY.
E.A.Turov and I Mitsek.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1127-32 (Oct., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 37(10), No. 4, 801-5 (April, 1960).

The phenomenological spin wave theory is used to evaluate the temperature dependence of the magnetic anisotropy free energy in ferromagnets in the low temperature region. It is shown that if the usual expressions are used for this free energy, the temperature dependence of the anisotropy constant of N-th order may depend substantially on the magnitude of the ratio at 0° K of the subsequent constants to the one given. The mixing of anisotropy constants of different orders in the equations for their temperature dependence disappears only when the anisotropy energy is written in the form of an expansion in homogeneous harmonic polynomials (in the direction cosines of the magnetization vector relative to the crystals axes) It then turned out that in the low temperature region the temperature dependence of the anisotropy constants, established theoretically by Zener (Abstr. 1980 of 1955) is only approximately valid.

539.2 : 538.2

11837 ON A METHOD OF MEASUREMENT OF MAGNETIC ANISOTROPY IN A WIDE TEMPERATURE RANGE.
G.Schoffa, O.Ristau and G.Mai.
Exper. Tech. der Phys., Vol. 7, No. 5, 217-224 (1959). In German.

A technique for measurements on feebly anisotropic substances using a torsion method is discussed. A.J.Manuel

539.2 : 538.2

11838 THE INDUCED MAGNETIC ANISOTROPY IN EVAPORATED FILMS OF NICKEL–IRON ALLOYS.
M.Prutton and E.M.Bradley.
Proc. Phys. Soc., Vol. 75, Pt 4, 557-74 (April 1, 1960).

The theories of the magnetic anisotropy of polycrystalline nickel–iron films in the Permalloy region of composition are briefly reviewed. A simple model is then described for the magnetic anisotropy which can be induced in such films during evaporation. This model includes the sum of the effects of iron-pair directional ordering and a constant linear stress lying along the annealing field. After a detailed description of the experimental technique used to prepare NiFe films about 1500 A thick in the region of composition 80-85%

ckel, the results of observations of the hysteresis loops measured
400 c/s are used to derive values of the anisotropy field H_k which
re then compared with the values expected should the simple model
ply. The experimental observation that increasing the substrate
mperature moves the minimum in anisotropy energy to lower nickel
ntent in the film is supported by the simple model. When the com-
licating effects of fibre growth are included, the major features of
e observations are found to agree quite well with the model but the
haviour of the induced anisotropy is shown to be complex and the
ssibility of contributions due to imperfection ordering are dis-
ssed.

539.2 : 538.2

11839 REDUCTION IN COERCIVE FORCE CAUSED BY A CERTAIN TYPE OF IMPERFECTION. A.Aharoni.
hys. Rev., Vol. 119, No. 1, 127-31 (July 1, 1960).

As a first approach to the study of the dependence of the coercive
rce on imperfections in materials which have high magnetocrystal-
ne anisotropy, the following one-dimensional model is treated. A
aterial which is infinite in all directions has an infinite slab of fi-
ite width in which the anisotropy is 0. The coercive force is calcu-
ted as a function of the slab width. It is found that for relatively
mall widths there is a considerable reduction in the coercive force
ith respect to perfect material, but reduction saturates rapidly so
at it is never by more than a factor of 4.

539.2 : 538.2

11840 STUDY OF THE MAGNETIZATION IN A SINGLE CRYSTAL OF SILICON—IRON BY FERROMAGNETIC
ESONANCE. A.Coumes.
.R. Acad. Sci. (Paris), Vol. 250, No. 21, 3458-60 (May 23, 1960).
French.

The resonance experiments are used to follow the rotation of
e magnetization away from an easy direction of magnetization in
field applied in an arbitrary direction. Both the direction of the
agnetization and the normal component of magnetization can be
easured. The method is thought to be of particular value in study-
g the magnetization in systems of hexagonal symmetry.

D.J.Oliver

539.2 : 538.2

11841 EXCHANGE ANISOTROPY IN DISORDERED NICKEL—MANGANESE ALLOYS. J.S.Kouvel and C.D.Graham, Jr.
Phys. Chem. Solids, Vol. 11, No. 3-4, 220-5 (Oct., 1959).

Disordered polycrystalline nickel—manganese alloy specimens
about 20, 25 and 30 atomic per cent manganese were cooled from
0 to 1.8°K in a magnetic field, and their magnetic hysteresis
ops measured parallel to this field are found to be displaced from
eir symmetrical positions about the origin. Upon warm-up, the
splacement of the loops decreases monotonically, vanishing at
out 25, 35 and 75°K for the 20, 25 and 30 atomic per cent man-
nese specimens, respectively. The disappearance of this asym-
etry with increasing temperature is accompanied by large hystere-
s losses. Torque measurements were made on the same speci-
ens cooled to 4.2°K in a field perpendicular to the axis of rotation.
or all compositions, the predominant anisotropy is unidirectional,
ith the easy direction the same as the direction of the field applied
ring cooling. The magnitude of this anisotropy decreases mono-
nically with increasing temperature, vanishing at the same
mperatures as the asymmetry of the hysteresis loops. At these
mperatures, the rotational hysteresis rises to a maximum. These
fects are believed to be due to exchange-anisotropy interactions
tween very small regions of ferromagnetic and antiferromagnetic
in order in these alloys at low temperatures.

539.2 : 538.2

11842 STRONG FIELD MAGNETIZATION AT LOW TEMPERATURES AND APPROACH TO ABSOLUTE SATURATION
F THULIUM METAL. W.E.Henry.
. appl. Phys., Suppl. to Vol. 31, No. 5, 323S-324S (May, 1960).

Magnetization studies of metallic thulium have been carried out
low temperatures and in magnetic fields up to 70 000 G. Near
0°K, the magnetization (M) is linear in field and reached 0.8 Bohr
agnetons per atom of thulium at 70 000 G. At 4.2°K, a magnetization
rve is traced in which the direction of concavity changes twice. In
e high field range, $(\partial M/\partial H)$ is decreasing and between 60 000 and
000 G, it is very small. At 70 000 G, the magnetization reaches 3.4
ohr magnetons per atom of thulium, suggesting the validity of the
$_{7/2}$ ground state assignment for metallic thulium. At 1.3°K, the
agnetization is slightly lower at equivalent fields, but approaches the same 70 000 G value as at 4.2°K. The remanence is 0.3 Bohr magneton per atom at 4.2°K and 0.4 Bohr magneton per atom at 1.3°K. A pronounced hysteresis is observed in the liquid helium range. A sample motion technique is used in the measurements and the calibration carried out with pure nickel.

539.2 : 538.2

11843 MAGNETIZATION OF A DILUTE SUSPENSION OF A MULTIDOMAIN FERROMAGNETIC.
C.P.Bean and I.S.Jacobs.
J. appl. Phys., Vol. 31, No. 7, 1228-30 (July, 1960).

The observed magnetization curve of a dilute suspension (in plastic clay) of carbonyl iron powder, type E, is shown to be closely that one would derive from consideration of a dilute assembly of randomly oriented, single-crystal, multidomain spheres. The deviations are in the directions expected from the effects of stress and non-spherical clumping. The effects of packing and the applicability of various laws of approach to saturation are discussed.

539.2 : 538.2 : 536.48

11844 MAGNETIC PROPERTIES OF FERROMAGNETIC SUPERCONDUCTORS. R.M.Bozorth and D.D.Davis.
J. appl. Phys., Suppl to Vol. 31, No. 5, 321S-322S (May, 1960).

Solid solutions of $GdRu_2$ in $CeRu_2$ are known to be superconducting and ferromagnetic. Magnetic measurements are reported for the 4 and 8% alloys; these show negative initial susceptibility (zero permeability) and hysteresis loops characteristic of superconductors. The 8% alloy shows typical ferromagnetic saturation and hysteresis at 5°K, and at 1.3°K it appears to be both ferromagnetic and superconducting at the same time. Detection of ferromagnetism in the superconducting 4% alloy is difficult and could not be established.

539.2 : 538.2

11845 MAGNETIC BEHAVIOR IN THE TRANSITION REGION OF A HEMATITE SINGLE CRYSTAL. S.T.Lin.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 273S-274S (May, 1960).

The magnetic behaviour in the transition region of a haematite single crystal from Elba has been investigated carefully. The remanence-temperature relationship and the thermal hysteresis effect (i.e., the remanence is a double-valued function of temperature) have been obtained for each of three mutually perpendicular directions of the crystal in the temperature range between 488° and 77°K. A graphical representation of the ferromagnetic state has been constructed to show the direction, the magnitude, and the turning of the remanent magnetization vector with the temperature in the transition region. Another experiment, which consists of measuring the remanence along different directions in the plane containing the [111] direction, and the projection of the remanent magnetization vector in the (111) plane for three different temperatures, also has been carried out. These experimental data show that the direction and the magnitude of the remanent magnetization vector changes continuously between the [111] direction and the (111) plane when the temperature changes through the transition region.

539.2 : 538.2

11846 THERMOMAGNETIC BEHAVIOUR OF FERROMAGNETIC DOMAIN NUCLEI. P.F.Davis.
Proc. Phys. Soc., Vol. 75, Pt 5, 739-44 (May, 1960).

Certain features of the thermomagnetic behaviour of a single-crystal specimen of silicon—iron when being magnetized in an easy direction of magnetization are explained in terms of the presence of domain nuclei in the specimen, following the work of Bates, Christoffel, Clow and Davis. (see Abstr. 237 of 1958).

539.2 : 538.2

11847 THE INFLUENCE OF TEMPERATURE ON THE EDDY CURRENT ANOMALY FACTOR.
L.Alberts and B.J.Shepstone.
Proc. Phys. Soc., Vol. 75, Pt 4, 539-42 (April 1, 1960).

The difference between the classically calculated and measured value for the eddy-current loss in magnetic sheet materials has been ascribed to the existence of a discrete domain structure in the material. In this investigation the theory was tested by altering the domain structure in an iron specimen through raising the temperature up to the Curie point. The results indicate that in principle the domain hypothesis is correct. The influence of the applied frequency on the eddy-current anomaly factor was measured and agrees with the qualitative deductions based on the domain model.

539.2 : 538.2

11848 THE APPLICATION OF NEUTRON DIFFRACTION TO THE STUDY OF MAGNETIC SUBSTANCES. P.Mériel.
Cahiers de Phys., Vol. 113, 29-34 (Jan., 1960). In French.

A short general review article. D.J.Oliver

539.2 : 538.2

11849 NEUTRON DIFFRACTION INVESTIGATIONS OF THE MAGNETIC ORDERING IN RARE EARTH NITRIDES.
M.K.Wilkinson, H.R.Child, J.W.Cable, E.O.Wollan and W.C.Koehler.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 358S-359S (May, 1960).

Neutron diffraction investigations on HoN and TbN at low temperatures show that both compounds become ferromagnetic with Curie temperatures of about 18° K and 43°K, respectively. Although the paramagnetic scattering is consistent with moment values calculated for the free trivalent rare-earth ions, the observed ferromagnetic moments are lower than the calculated values and indicate the effect of crystalline field interactions. Diffraction patterns from both compounds at 1.3°K show considerable ferromagnetic short-range-order scattering with characteristics which are different from those associated with critical magnetic scattering.

539.2 : 538.2

11850 MAGNETIC STRUCTURE OF Mn_4N.
W.J.Takei, G.Shirane and B.C.Frazer.
Phys. Rev., Vol. 119, No. 1, 122-6 (July 1, 1960).

The magnetic structure was determined by neutron diffraction from powders. The cubic unit cell has Mn at the corner and face centres and N at the body centres. Standard diffraction techniques led to four possible models and it was necessary to perform polarized neutron beam experiments to resolve this ambiguity. The structure is ferrimagnetic with a corner moment of 3.5 μ_B antiparallel to the three face centre moments of 0.7_7 μ_B.

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11851 NEUTRON DIFFRACTION INVESTIGATION OF THE ANTIFERROMAGNETISM OF THE CARBONATES OF MANGANESE AND IRON. R.A.Alikhanov.
Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1690-6 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), 1204-8 (Dec., 1959).

A procedure was developed for low-temperature powder neutron diffraction. The antiferromagnetic structure of $MnCO_3$ and $FeCO_3$ was investigated. It is shown that in the antiferromagnetic state, the spins in $MnCO_3$ lie in the basis plane and in the symmetry plane. In $FeCO_3$, the spins are directed along the rhombohedral axis. According to Dzyaloshinskii (Abstr. 3224 of 1958), this means that $MnCO_3$ is weakly ferromagnetic and $FeCO_3$ is not.

539.2 : 538.2

11852 MAGNETIC PROPERTIES OF POLYCRYSTALLINE MATERIALS.
D.M.Grimes, R.D.Harrington and A.L.Rasmussen.
J. Phys. Chem. Solids, Vol. 12, No. 1, 28-40 (Dec., 1959).

The variation of the magnetic Q with internal magnetization is discussed, using both the domain rotation and the domain-wall motion model of magnetization change. The variation of the reversible susceptibilities with magnetic moment is reported on four samples, and the results are compared with results from the frequency spectra in the initial and remanent states. The distribution of magnetic moments in the system as a function of the angle between individual and averaged moments is discussed in terms of an infinite series expansion in Legendre polynomials. The coefficients of the first four terms can be measured. Experimental data are given for the first three.

539.2 : 538.2

11853 SOME PHYSICAL PROPERTIES OF THIN MAGNETIC FILMS. A.C.Moore and A.S.Young.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 279S-280S (May, 1960).

In films of nickel iron evaporated under suitable conditions, the magnetocrystalline anisotropy is averaged out by the random array of small crystallites. The stress in the films cannot be eliminated but its effect is made insignificant by using alloys whose mean magnetostriction is zero. In these particular films, no evidence is found of angle of incidence effect but it is shown that they may contain traces of oxide. It is easier to obtain uniformity in magnetic properties of a number of elements in a plane if the magnetic film is made continuous and edge effects are excluded. No interaction takes place between adjacent areas when spaced ½ cm apart. This spacing can probably be reduced by a factor of at least two without interaction trouble.

539.2 : 538.2

11854 CROSS-TIE WALLS IN THIN FILMS.
H.Rubinstein and R.J.Spain.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 306S-307S (May. 1960).

Various properties of cross-tie walls are summarized. Several new Bitter pattern experiments dealing with cross-tie walls are described. The first experiment firmly determines the magnetization distribution about a cross-tie, with the aid of an applied field at 45° to the wall. The second experiment tests the stability of cross-tie walls. It is shown in this experiment that another wall configuration is possible. This is discussed in light of the buckling mechanism of film switching.

539.2 : 538.2 : 539.27

11855 STATIC AND DYNAMIC STUDIES OF MAGNETIZATION DISTRIBUTION IN THIN FILMS BY ELECTRON MICROSCOPY. H.W.Fuller and M.E.Hale.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 308S-309S (May, 1960).

Several modes of operation of a transmission electron microscope are discussed which are useful for the observation of the magnetization distribution in thin films. Gross defocusing of the instrument provides great sensitivity to slow variations in static magnetization at high resolution. The applications of electron microscopy to dynamic wall studies is discussed; this can be demonstrated by motion pictures. Some new ways of observing domains and walls at instrumental focus are described which utilize an opaque knife edge for intercepting a fraction of the deflected electron beam below the specimen.

539.2 : 538.2

11856 AN ILLUSTRATIVE ACCOUNT OF COHERENT MAGNETIZATION ROTATIONS IN THIN FERROMAGNETIC FILMS. E.Feldtkeller.
Z. angew. Phys., Vol. 12, No. 6, 257-61 (June, 1960). In German.

Gives a graphical description of the orientation and rate of rotation of the magnetization vector in terms of the energy contributions and the damping constant. E.P.Wohlfarth

539.2 : 538.2

11857 MILLIMICROSECOND MAGNETIZATION REVERSAL IN THIN MAGNETIC FILMS.
W.Dietrich and W.E.Proebster.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 281S-282S (May, 1960).

A special pulse equipment including a pulse sampling oscilloscope with an overall response time of 0.35 mμsec for the observation of the millimicrosecond flux reversal in thin permalloy films is described. Output signals as short as 1 mμsec have been obtained and are discussed with respect to the underlying reversal processes. Inverse switching times versus driving field curves have slopes of about 10^8/Oe sec. Coherent rotation and oscillation of the magnetization have been clearly detected by picking up the flux change transverse to the driving field.

539.2 : 538.2

11858 FLUX REVERSAL BY NONCOHERENT ROTATION IN MAGNETIC FILMS. K.J.Harte.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 283S-284S (May, 1960).

A model of magnetization reversal in thin ferromagnetic films is proposed. The model is based on a small angular dispersion (~ 3°) in the film plane of the axis of planar anisotropy. The dynamical effects of this dispersion are important when the switching field (H_S) is of the order of the anisotropy field, fall off rapidly with increasing H_S, and include a two- to three-fold increase in the switching coefficient for bias field large enough to insure unidirectional rotation. In addition, it is shown that the transverse flux reaches its maximum before the longitudinal flux is one-half switched. These results are in reasonable agreement with experiment.

539.2 : 538.2

11859 MAGNETIZATION REVERSAL IN UNIAXIAL FILMS NEAR TO THE PREFERRED DIRECTION.
E.M.Bradley and M.Prutton.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 285S-286S (May, 1960).

It is known that uniaxial thin magnetic films can be made which have almost ideal square hysteresis loops in the preferred direction

almost straight line hysteresis loops in the hard direction. For
n prepared by evaporation of approximately 81 : 19 NiFe alloy, it
found that the switching time constant of the reversal process
en magnetic fields are applied exactly in the easy direction can be
y large. The switching process occurring when fields are applied
10° to the preferred direction has been studied both by a new pulse
sponse technique, and by observation of the domain structure using
Kerr magneto-optic effect. In the latter experiment, short pulses
ve been applied to the specimen and photographs taken of the
nain pattern after each pulse. It was found that the specimen
aks into small domains whose area increases after each pulse and
t eventually the film could be completely reversed if the pulse
plitude was between certain critical values. Curves were plotted
the pulse amplitude against the proportion of the film switched,
nd by measuring the reversed area in the photographs. It was
wn that the process is very well approximated by an equation of
form $S_W = \tau(H - H_0)$, which implies a viscous damped process,
there is a critical nucleation field, which is less than the field
uired to move the walls. In the pulse response experiments, the
tching time was derived from the response to a reset pulse applied
er a variable number of set pulses of variable amplitude. It was
nd that in some films there can be a rapid switching process,
ch is complete after about 100 mμsec, followed by a slow process
ting up to 10 μsec. From experiments a switching time constant
be computed which can be very large in some films. This con-
nt can be correlated with the ratio $p = H_C/H_K$, where H_C is the
rcivity in the easy direction and H_K is the rotational coercivity.
he film obeyed the simple coherent rotational model the p ratio
ld be 1, and films which have p = 0.9 have been found to have
$= 0.3 \times 10^{-6}$ Oe μsec, whereas for p = 0.3, $S_W = 7 \times 10^{-6}$ Oe μsec.

539.2 : 538.2

11860 INFLUENCE OF NEARBY CONDUCTORS ON THIN FILM SWITCHING. J.S.Eggenberger.

ppl. Phys., Suppl. to Vol. 31, No. 5, 287S-288S (May, 1960).

The usual concept of a thin film or other open flux path magnetic
ment consists of the material itself closely encircled by drive
sense conductors. Strip of conductor of width approximately that
he element are attractive for several reasons, i.e. low resistance,
skin effect, and low line impedance. However, these strips, be-
closely coupled to the element, can severely influence its dynamic
perties by means of induced eddy currents. These conductors
nifest themselves in three ways: 1. A slowing of the switching
to the air return flux path of the element passing through a con-
tor and being damped. 2. A dynamic distortion of the air return
k due to shielding effects. 3. A dynamic distortion of an applied
d due to shielding effects. All of these effects can be detrimental
he operation of the element. In this paper, approximate calcula-
ns are presented to show the extent of these effects. The geo-
try considered is that of a "conventional" flat thin film element,
ven and sensed by strip transmission lines. Several drive and
se configurations are considered, and experimental evidence is
sented in support of these calculations. Although the cases con-
ered are somewhat arbitrary, the methods and many of the re-
ts are applicable to other cases of utilization of open flux path
ments.

539.2 : 538.2

11861 PREFERRED ORIENTATION AND ORDERING IN EVAPORATED FILMS OF Fe, Ni, AND Fe-Ni.

Adamsky.
ppl. Phys., Suppl. to Vol. 31, No. 5, 289S-290S (May, 1960).

Studies of the effect of evaporation angle on orientation tend-
ies have shown the effect to be insignificant for certain evapora-
conditions. Thickness gradients and particle size variations
the major effects of variation of incidence angle in these experi-
nts. Slight degrees of preferred orientation in the form of [111]
e axes have been found for Fe, Ni, and permalloy films deposited
heated substrates. Annealing experiments have shown the pres-
e of superlattice ordering in permalloy films held for short
iods of time at 200° C.

539.2 : 538.2 : 548.5

11862 NUCLEATION EXPERIMENTS ON THIN MAGNETIC MnBi FILMS. L.Mayer.

ppl. Phys., Suppl. to Vol. 31, No. 5, 384S-385S My, 1960).

Experiments devised to provide information about the nucleation
bability of ferromagnetic MnBi films are described. These
eriments revealed that uniform magnetic MnBi films growb from
y a few randomly distributed nucleation sites. Thus nucleation is of considerable importance in the repatation of magnetic MnBi films. Further studies aimed at controlling this nucleation behaviour are therefore indicated. First experiments directed toward this goal showed that 100% nucleation occurs if the Mn—Bi layer which is to be transformed is deposited on an already formed magnetic MnBi film. The magnetic field of this premagnetized MnBi film substrate is the cause for the development of extremely large domains but the high efficiency of nucleation seems to stem simply from the direct contact with the already finished MnBi film substrate.

539.2 : 538.2

11863 THE INFLUENCE OF EDGE EFFECTS ON DOMAIN STRUCTURE AND COERCIVE FORCE OF CIRCULAR NICKEL—IRON FILMS. M.Beckerman and K.H.Behrndt.

I.B.M. J. Res. Developm., Vol. 4, No. 2, 198-201 (April, 1960).

The coercive force of permalloy films increases and spiked edge domains are observed when the edge regions are relatively thinner than the interior of the films due to evaporation through a mask. The effect is reduced after removal of the edge regions by etching, which also reduces the variability of the coercive force.

E.P.Wohlfarth

539.2 : 538.2

11864 DOMAIN WALL VELOCITIES IN THIN IRON—NICKEL FILMS. N.C.Ford, Jr.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 300S-301S (May, 1960).

An apparatus based on the Kerr magneto-optical effect has been used to measure the velocity of domain walls in thin iron-nickel films. Polarized light, after being reflected by a film, is analysed and detected by a photomultiplier tube. The slope of an oscilloscope trace resulting from the photomultiplier signal is directly proportional to the domain wall velocity, as the wall traverses a light spot of known size. Wall velocities are found to be well described by an equation of the form $v = m(H - H_0)$, where m is the wall mobility and $H - H_0$ the excess applied field. Measurements have been made on films varying in thickness from 4000 to 700 A with corresponding mobilities of 0.5×10^4 cm.sec.$^{-1}$ Oe for the thicker film and 4.9×10^4 cm.sec.$^{-1}$Oe for the thinner film. The wall mobility is found to be inversely proportional to $B_S\sigma d$ where σ is the electrical conductivity and d the film thickness. This is the dependence that is predicted on the basis of a simple eddy current model indicating that, even in films as thin as 700 A, the dominant loss mechanism in wall motion is caused by eddy currents rather than intrinsic damping of the Landau—Lifshitz type.

539.2 : 538.2

11865 DOMAIN WALLS IN THIN MAGNETIC Ni—Fe FILMS. S.Methfessel, S.Middelhoek and H.Thomas.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 302S-304S (May, 1960).

Néel proposed a transition from the normal type of domain wall (rotation of the magnetization vector in the plane of the domain wall) to the Néel type (rotation of the magnetization vector in the plane of the film) at a certain film thickness, which is due to the thickness dependence of the magnetostatic energy. It is suggested that the cross-tie walls observed in thin Ni—Fe films with uniaxial anisotropy correspond to such a transition, in which the cross ties serve to decrease the magnetostatic energy. According to this explanation, such a structure should occur in a certain thickness range only. Experimental observations on Ni—Fe wedge-shaped films show the occurrence of the cross-tie structure in the thickness range 400-900 A, which is approximately that predicted by theory. The coercive force shows an anomaly in the same range. The energy reducing function of cross ties is also shown by the Bitter patterns near scratches in the easy direction in negative magnetostrictive material. In a region along the scratch, the magnetization in the plane of the film is perpendicular to the original easy direction due to the local stresses and again a cross-tie structure is observed.

539.2 : 538.2

11866 ANNULAR UNIAXIALLY MAGNETIZED DOMAINS IN THIN Ni—Fe FILMS.

O.W.Muckenhirn, A.E.LaBonte and P.J.Besser.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 304S-306S (May, 1960).

Stable annular uniaxially magnetized domains have been observed in thin circular Ni—Fe films using both the Kerr and Faraday magneto-optic effects. The films exhibit unusual magnetic behaviour in both the "easy" and "hard" directions. Generally the magnetization reversal begins at the circumference of the film with the appearance of a uniaxially magnetized annular domain whose inner radius then decreases with increasing applied field. In a number of films, the mechanism of magnetization reversal in an outer annular region appears to be distinctly different from that in the central region. In the annular region, the low-frequency magnetization reversal in the easy direction proceeds by wall motion with the Bloch walls approximately parallel to the direction of the applied field, but there is evidence that the reversal in the hard direction occurs by a rotational process. After the annular region is completely reversed, the centre region is reversed by a radially inward motion of the circular boundary between the two concentric uniaxially magnetized domains. The magneto-optic observations are qualitatively correlated witn 60 c/s $d\phi_M/dt$ versus H and ϕ_M versus H loop data. Based on the assumptions of uniform magnetization per unit volume, M, and uniform film thickness, quantitative correlation of ϕ_M versus H as obtained from Kerr effect photographs and from normalized 60 c/s hysteresis loop measurements have been made and are reported.

539.2 : 538.2

11867 INVESTIGATIONS INTO THE ORIGIN OF ANISOTROPY IN OBLIQUE-INCIDENCE FILMS.

M.S.Cohen, E.E.Huber, Jr, G.P.Weiss and D.O.Smith.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 291S-292S (May, 1960).

Experimental evidence is presented which shows that the magnetic anisotropy of oblique-incidence Permalloy and iron films is not caused by an inclined texture axis or anisotropic strain. Electron diffraction and microscopy have not yet revealed anisotropy in the crystalline microstructure of these films. These techniques have also thus far failed to reveal the existence of agglomeration of the crystallites into small groups having anisotropic geometric shapes. Magnetic anisotropy, on the other hand, was observed in Permalloy films deposited at normal incidence on nonmagnetic metal films deposited at oblique incidence; this would suggest such an agglomeration mechanism. There is also some indication that oxygen may play a role in oblique-incidence magnetic anisotropy.

539.2 : 538.2

11868 MAGNETIC ANISOTROPY IN EVAPORATED IRON FILMS.

E.W.Pugh, J.Matisoo, D.E.Speliotis and E.L.Boyd.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 293S-295S (May, 1960).

A torque method has been used to measure the magnetic anisotropy of iron films deposited from the vapour at various incident angles on glass substrates. The anisotropy is found to be largest in films prepared with large incident angles and low substrate temperatures. A theoretical calculation of the anisotropy expected in an iron film with a [111] fibre axis has been made for various angles of the fibre axis and as a function of stress in the film. The theoretically calculated values are not only an order of magnitude lower than most measured anisotropies, but they always have the wrong sign. Iron films deposited on rocksalt exhibit anisotropies before and after removal from the substrate which indicate that the anisotropy is affected by cold-working but not by stress relief. It is concluded that the magnetic anisotropy in iron films is primarily related to the faulted regions formed in the films during deposition and not to stress or the proposed fibre axis structure.

539.2 : 538.2

11869 ANISOTROPY AND INVERSION IN PERMALLOY FILMS.

D.O.Smith, E.E.Huber, Jr., M.S.Cohen and G.P.Weiss.

J. appl. Phys , Suppl. to Vol. 31, No. 5, 295S-297S (May, 1960).

A phenomenological model of field-induced and oblique-incidence anisotropy in Permalloy films is proposed. It is assumed that the field-induced structure does not introduce any local spatial dispersion in the macroscopic magnetization M; the opposite is assumed for oblique-incidence structure. In addition it is assumed that the oblique-incidence dispersion is anisotropic, being least when M is perpendicular to the depositing beam. Support for the model comes from anisotropies, found for oblique-incidence films only, in the following measurements: resonance line width, transmission of polarized light, and resistivity. A primary success of the model is the prediction of a correlation between anisotropy and inversion ($H_W/H_K > 1$). Inverted films can be made by crossing the field-induced and oblique-incidence anisotropies at 90°. Such films exhibit a "locked" state in which opposite rotation of M in local regions occurs; this implies centres of spatial dispersion and provides the connection with oblique-incidence anisotropy. A method of inducing anisotropy by means of a moving substrate is described. The assumption of local dispersion is shown to apply to this type of anisotropy also. Finally, a guide to understanding the interdependence of H_K and H_W is given in terms of the anisotropy model: field-induced structure does not have any effect on H_W, while oblique-incidence structure can be a primary determinant for H_W.

539.2 : 538.2

11870 PARTICLE INTERACTION IN MAGNETIC RECORDING TAPES. J.G.Woodward and E.Della Torre.

J. appl. Phys., Suppl to Vol. 31, No. 5, 398S (May, 1960).

Brief note, substantially as follows. The magnetic coating of recording tape is assumed to be composed of an assemblage of small single domain particles. Each particle is assumed to have a symmetrical, square hystersis loop when the reversible component of magnetization is neglected and when the particle is not influenced by the fields of neighbouring particles. When influenced by the fields of its neighbours, the particle may exhibit an asymmetrical loop when the loop is plotted relative to an external applied field. In this case, the positive and negative switching fields for the particle are not equal, the their difference gives an indication of the particle interaction. While it is not possible to measure the switching fields of a single particle on the recording tape, the distribution of switching fields in the assemblage of particles can be measured, along with the distribution of magnetic moments associated with the switching fields. The two switching fields and the magnetic moment define a 3-dimensional distribution function which describes the magnetic properties of the tape, and in terms of which both d.c. and anhysteretic magnetization processes may be described. The distribution functions have been measured for two recording tapes. While the functions for the two tapes are markedly different in detail, both show that particle interaction is very appreciable in recording tapes and that it is a significant factor in determining the bulk magnetic properties and the recording performance of tapes.

539.2 : 538.2

11871 STATE EQUATIONS DEFINING THE MAGNETO-ELASTIC PROPERTIES OF FERROMAGNETIC SINGLE CRYSTALS. K.B.Vlasov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 889-94 (March, 1960). In Russian.

A thermodynamic deduction is given (for small magnetization and deformation changes) of the state equations which define the magnetomechanical properties of magnetically polarized ferromagnetic single crystals possessing hexagonal symmetry. It is shown that in the case of inhomogeneous deformations the equilibriu mechanical stress and magnetic field values are connected by the state equations not only to the magnetization vector and deformation tensor but also to the rotation tensor which determines the orientation of the volume element under consideration. On the basis of the results obtained some conclusions are drawn concerning the features of the velocity of propagation and rotation of the plane of polarization of transverse elastic waves in ferromagnetics.

539.2 : 538.2

11872 THE "IMPROPER" ΔG-EFFECT IN NICKEL. K.Mišek and E.Kratochvílova.

Czech. J. Phys., Vol. 9, No. 3, 405-6 (1959). In German.

The elastic modulus G was measured for nickel specimens as a function of d.c. and mean a.c. magnetic field strengths and found to have minima close to the internal friction peaks. E.P.Wohlfarth

539.2 : 538.2

11873 A MAGNETOMECHANICAL METHOD FOR THE STUDY OF THE KINETICS OF MAGNETIZATION PROCESSES.

B.Rothenstein.

Czech. J. Phys., Vol. 9, No. 3, 410-11 (1959). In German.

Measurements of the internal friction of iron specimens in combined d.c. and a.c. fields were used to determine the change with field of the volume of the material having a given coercive forc See also Abstr. 6230 of 1960. E.P.Wohlfart

539.2 : 538.2 : 539.

11874 TEMPERATURE DEPENDENT MAGNETIC CONTRIBUTIONS TO THE HIGH FIELD ELASTIC CONSTANTS OF NICKEL AND AN Fe–Ni ALLOY.

G.A.Alers, J.R.Neighbours and H.Sato.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 40-55 (May, 1960).

Since the fundamental interaction between magnetic moments in a ferromagnet makes a contribution to the total energy, there shoul also be a corresponding contribution to the elastic constants. In order to observe this effect, the elastic constants C_{44}, $\frac{1}{2}(C_{11}-C_{12})$ an $\frac{1}{2}(C_{11}+C_{12}+2C_{44})$ have been measured in nickel and an Fe–30% Ni alloy through their respective Curie temperatures at high enough applied magnetic fields to eliminate the ordinary "ΔE effect" assoc ated with domain wall motion. The intrinsic magnetic interaction which should produce changes in the elastic constants upon passing

rough the Curie temperature was clearly observed in both mater-
ls. The first and the second derivatives of the exchange energy
e estimated from these results. Such an interpretation is relatively
raightforward for nickel, but the large volume magnetostriction of
e Fe—Ni alloy makes the analysis of the data difficult. The meas-
ements on nickel were extended down to 4.2°K while those on the
loy do not go below room temperature because of a possible
ırtensitic transformation of this alloy.

539.2 : 538.2

11875 THE SATURATION MAGNETOSTRICTION OF FERROMAGNETICS. R.R.Birss.

dvances in Phys., Vol. 8, 252-91 (Oct., 1959).

A review of the spontaneous and forced magnetostriction of
ngle crystals and polycrystals, particularly the ferromagnetic metals
d their alloys. The spontaneous magnetostriction constants in
ıbic and hexagonal single crystals are related to the elastic coef-
cients and magneto-elastic coupling constants. There is disagree-
ent with Kittel's result for cubic crystals (Abstr. 2563 of 1950).
table of collected experimental values of the elastic coefficients
Fe, Ni and Co is given. It is noted that the observed magneto-
rictive behaviour of single crystals of Fe, Co and Ni and many of
eir alloys can be described by only two constants. The author
ports recent measurements on the polycrystalline saturation
agnetostriction constant in Fe (-5.6×10^{-6}) and on the relations
tween the single crystal and polycrystalline saturation magneto-
riction constants in Ni over an extended temperature range.
e results support Lee's conclusion (Abstr. 8075 of 1955) that the
ress in a polycrystal may be assumed uniform and that the poly-
ystalline magnetostriction may thus be obtained by averaging the
ngle crystal magnetostriction over all orientations. The thermal
pansion anomaly is discussed. 70 references.

D.M.Edwards

539.2 : 538.2

11876 MEASUREMENT OF MAGNETOSTRICTION WITHIN THE TEMPERATURE RANGE −196 to 400°C.

R.Birss and E.W.Lee.

sci. Instrum., Vol. 37, No. 7, 225-30 (July, 1960).

An apparatus is described which permits the magnetostrictive
haviour of small single-crystal or polycrystalline specimens to
investigated over a range of temperatures from −196 to 400°C.
esistance strain gauges are employed and the performace of a num-
r of gauges has been investigated at these temperatures. Details
e given of the techniques used to obtain a reliable overall strain
nsitivity of 2×10^{-7} per mm deflexion of the indicating galvano-
eter. The procedure by which the single-crystal magnetostriction
nstants may be obtained from strain measurements at saturation is
tlined for the case of a disk-shaped crystal in which the plane of
e disk is normal to one of the three principal crystallographic
rections.

539.2 : 538.2

11877 THE TEMPERATURE DEPENDENCE OF MAGNETOSTRICTION IN POLYCRYSTALLINE GADOLINIUM.

D.Corner and F.Hutchinson.

oc. Phys. Soc., Vol. 75, Pt 5, 781-8 (May, 1960).

The magnetostriction and magnetization of an ellipsoid of poly-
ystalline gadolinium were measured in the temperature range 78°K
365°K. The results show that gadolinium has a large volume mag-
tostriction which is proportional to the square of the paramagnetic
ıgnetization above the Curie point. The saturation magnetostriction
ows an anomaly at 150°K, and becomes zero at 233°K. The contri-
tion of the volume magnetostriction to the thermal expansion of
dolinium is shown to be too small to account for the thermal ex-
nsion anomaly.

539.2 : 538.2

11878 THEORY OF RELAXATION PROCESSES IN FERROMAGNETIC DIELECTRICS WITH A WEAK MAGNETIC ISOTROPY AT LOW TEMPERATURES.

G.Bar'yakhtar and G.I.Urushadze.

. eksper. teor. Fiz., Vol. 38, No. 4, 1253-62 (April, 1960).
Russian.

Relaxation of the magnetic moment and levelling out of the spin
d lattice temperatures in ferromagnetic dielectrics possessing a
y magnetic anisotropy and located in weak magnetic fields are
nsidered. It is shown that establishment of the equilibrium value
the magnetic moment with respect to its magnitude as well as
rection is due to magnetic dipole interaction. In this case the relaxation time of the magnitude of the magnetic moment is equal in order of magnitude to the time of rotation of the magnetic moment toward the equilibrium direction. The spin and lattice equilibrium time is also calculated.

539.2 : 538.2

11879 SOFT MAGNETIC MATERIALS. E.W.Lee and A.C.Lynch.

Advances in Phys., Vol. 8, 292-348 (Oct., 1959).

A comprehensive review of developments since 1950 in experimental techniques, results, and their interpretation. 215 references.

A.J.Manuel

539.2 : 538.1

11880 GROWING SPIN WAVES IN FERRITES IN UNSTABLE EQUILIBRIUM. T.Schaug-Pettersen.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 382S-383S (May, 1960).

This paper demonstrates that when the direction of the magnetic field in a saturated ferrite is inverted, spin waves occur which have an aperiodic exponential growth. The fastest growing of these waves have time factor $\exp(\Omega_M t/2)$ and their wave vector is oriented at right angles to the magnetic field. The significance of these waves for ferrite switching and microwave pulse generation is discussed briefly.

539.2 : 538.2 : 621.318.12

11881 SWITCHING BEHAVIOR OF LOW REMANENCE FERRITE. F.B.Hagedorn and E.M.Gyorgy.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 398S-400S (May, 1960).

Switching studies have been made on a low remanence ferrite. By using a sampling oscilloscope with a response time less than 5×10^{-10} sec, switching times shorter than 5×10^{-9} sec have been measured. About half of the flux in this ferrite appears to switch by nonuniform rotation, but even in small fields the remaining flux switches substantially faster than would be excepted on the basis of nonuniform rotational reversal. This observation is interpreted as further evidence of the existence of a ferrite flux reversal process in which switching is speeded up by an interaction between the magnetization and a demagnetizing field. In contrast to square loop ferrites, the threshold field for both processes in this low remanence ferrite is approximately zero.

539.2 : 538.2

11882 TEMPERATURE DEPENDENCE OF THE SATURATION MAGNETIZATION OF FERRITES WITH MAGNETOPLUMBITE STRUCTURE. G.Heimke.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 271S-272S (May, 1960).

The anomaly in the saturation magnetization versus temperature dependence of ferrites with magnetoplumbite structure is supposed to be caused by the fact that the superexchange interactions of the five crystallographically distinguished sublattices may be of several kinds in a part of the unit cell. It is shown that the interaction chain can be made to be of one kind only by replacement of the iron ions of one sublattice by nonmagnetic ions, and the conditions under which this replacement can be effected are pointed out. Experimental evidence demonstrates that this can partly be achieved by using $BaTiO_3$ instead of $BaCO_3$ in the starting mixture, if special precautions as to the sintering conditions are taken.

539.2 : 538.2 : 539.16

11883 HYPERFINE INTERACTIONS IN MAGNETIC MATERIALS BY γ—γ ANGULAR CORRELATION MEASUREMENTS.

M.E.Caspari, S.Frankel and M.A.Gilleo.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 320S-321S (May, 1960).

A method for measuring hyperfine interactions in magnetic materials by γ—γ angular correlation techniques is discussed. The change in the anisotropy of the 1415—122 keV γ—γ angular correlation following the K capture of Eu^{152} in neutron irradiated polycrystalline samples of europium iron garnet enriched in Eu^{151} has been measured as a function of temperature without applied magnetic field and the rotation of the angular correlation pattern has been observed when a magnetic field was applied perpendicular to the plane containing the γ counters. From these experiments, the effective magnetic field acting at the europium nuclei immediately after the radioactive decay can be obtained.

539.2 : 538.2

11884 MAGNETIC PROPERTIES OF GADOLINIUM OXIDES. K.P.Belov, M.A.Zaitseva and A.V.Ped'ko.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1672-9 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1191-6 (Dec., 1959).

Measurements of the temperature dependence of magnetic properties were made on gadolinium ferrites with garnet and perovskite structures, and also on gadolinium manganite. It was established that, in the garnet ferrite in the neighbourhood of the compensation temperature and of the Curie point, there occurs an anomalous increase of the coercive force and an extremely small paraprocess. The temperature dependence of the magnetostriction also exhibits an anomalous behaviour. The perovskite gadolinium ferrite has a weak ferromagnetism of the hematite type. The magnitude of this ferromagnetism increases after heating of the specimen above the Curie point in a field. Gadolinium manganite has paramagnetic properties; but in the helium temperature range, magnetic hysteresis phenomena are observed.

539.2 : 538.2

11885 MAGNETIC MOMENTS AND CURIE POINTS OF FERRITES OF THE Cu—Cd SYSTEM.

N.Z.Miryasov and L.G.Kolomin.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1935-6 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1376-7 (Dec., 1959).

Reports measurements of the saturation magnetizations and Curie temperatures of the ferrites $Cd_xCu_{1-x}Fe_2O_4$ with $0 \leq x \leq 0.8$.

E.P.Wohlfarth

539.2 : 538.2

11886 ON THE PROBLEM OF THE RECTANGULARITY OF THE HYSTERESIS LOOP OF MANGANESE FERRITE.

J.Šternberk.

Czech. J. Phys., Vol. 9, No. 3, 408-9 (1959).

The factors influencing the rectangular character of hysteresis loops in ferrites of the general composition $Mn_{1+x}Fe_{2-x}O_{4+\gamma}$ are considered. It is found experimentally that for most of the samples measured, the rectangularity of the hysteresis loops is determined essentially by the magnetocrystalline anisotropy, modified by the presence of the internal demagnetizing factor. Chemical composition appears not to affect the shape.

S.A.Ahern

539.2 : 538.2

11887 TIME DECREASE OF INITIAL PERMEABILITY IN $Mn_xFe_{3-x}O_{4+y}$. W.A.Crapo.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 267S-268S (May, 1960).

The time decrease of initial permeability has been measured for several stoichiometric and nonstoichiometric compositions of $Mn_xFe_{3-x}O_{4+y}$. The samples were in the form of polycrystalline toroids with compositions x = 0.5, 0.7, 0.85, and 0.9. The stoichiometric compositions, y = 0, were fired to maintain a metal-oxygen ratio of 3 : 4, while the nonstoichiometric samples were fired to produce the maximum vacancy concentration. The permeabilities were measured at a peak driving field of 0.002 Oe in the temperature range −15° to +35° C. The time decrease data was described by three relaxation times. Activation energies calculated on the basis of these relaxation times were within experimental error equal and independent of the Mn/Fe ratio, i.e. Q = 0.46 ± 0.06 eV. The activation energy for the nonstoichiometric samples was equal to that observed for the stoichiometric samples. The magnitude of the effect in the stoichiometric samples was found to decrease approximately linearly with the increasing Mn/Fe ratio.

539.2 : 538.2

11888 THE DISTRIBUTION OF IONS AND THEIR VALENCIES IN MANGANESE FERRITES. II. $Mn_{1+x}Fe_{2-x}O_{4+\gamma}$ FERRITES. J.Brož, S.Krupička and K.Závěta.

Czech. J. Phys., Vol. 9, No. 4, 481-7 (1959).

For Pt I, see Abstr. 3239 of 1960. The influence of the oxygen content on the saturation magnetic moment and on the Curie temperature was studied experimentally on non-stoichiometric manganese ferrites having a varying excess of manganese. By taking into consideration the results of studies on electrical conductivity and magnetic relaxation effects a model was elaborated for the distribution of ions in these ferrites, starting from a model for the distribution of ions in stoichiometric manganese ferrite. The experimental results obtained by the present and those of other authors confirm the justification of this model.

539.2 : 538.2

11889 PROPERTIES OF MANGANESE FERRITES PREPARED AT VARIOUS OXYGEN PRESSURES. A.Bragiński.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 339 S (May, 1960).

The following brief note is given. Manganese ferrite solid solutions $Mn_yFe_{3-y}O_{4+\gamma}$, $(0.87 < y < 1.14)$ were investigated. The samples were sintered at various temperatures and then cooled at various oxygen pressures. It was shown that the lattice defects formed during sintering facilitated both the reduction or oxidation processes during cooling depending upon the oxygen pressure applied. The concentration of defects at constant sintering temperature increased with the iron content, especially at $y < 1$.

539.2 : 538.2

11890 EFFECT OF POTASSIUM IONS ON THE REACTION AND FINAL PROPERTIES OF Mn—Zn FERRITE.

S.Makolagwa.

J. appl. Phys., Suppl. to Vol. 31, No. 4, 339S (May, 1960).

The following brief note is given. A Mn—Zn ferrite containing a slight iron excess was investigated. Small additions of potassium ions introduced into the initial mixture of raw oxides volatilize during sintering and accelerate the reaction process, thus facilitatin the reduction or oxidation of the ferrite, which depends on the oxyge pressure applied. The basic magnetic properties are greatly influenced by this. The effect may be explained by the formation of lattice defects.

539.2 : 538.

11891 SQUARE LOOP PROPERTIES OF COPPER—MANGANESE FERRITES. R.S.Weisz and D.L.Brown.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 269S-270S (May, 1960).

A survey of magnetic properties for the system $CuFe_2O_4$—$MnFe_2O_4$—Mn_3O_4 is reported. Saturation flux density, Curie temperature, coercivity, hysteresis loop squareness, and switching constant were determined for 60 compositions. A large compositional area having square loop properties was found. Apparently, both divalent Cu and trivalent Mn contribute to squareness. Switching constant was found to decrease markedly with increasing manganese content to a low in the neighbourhood of 0.6 Oe μsec. Coincident-current memory cores made from appropriate Cu—Mn ferrites have properties very similar to conventional Mg—Mn ferrites but at significantly lowered driving currents.

539.2 : 538.

11892 MAGNETIC AFTER-EFFECT DUE TO ELECTRON DIFFUSION IN MgMn FERRITES. S.Krupička.

Naturwissenschaften, Vol. 47, No. 7, 153-4 (1960). In German.

Measurements of disaccommodation and the frequency dependence of power factor as a function of temperature, suggest the existence of at least three different diffusion processes. The effect of temperature and manganese content of the ferrites on these processes is discussed.

A.J.Manuel

539.2 : 538.

11893 INTERACTIONS AND DISTRIBUTIONS OF MAGNETIC IONS IN SOME GARNET SYSTEMS.

R.M.Bozorth and S.Geller.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 263-7 (Oct., 1959).

The tetravalent ions of silicon, germanium and tin have been substituted in the garnet structure as, for example, in the solid solutions $\frac{1}{3}Ca_3Fe_2M_3^{4+}O_{12}$—$\frac{2}{3}Y_3Fe_2Fe_3O_{12}$. Measurements of the spontaneous magnetizations at low temperatures indicate that in these solid solutions about 95% of the small Si^{4+} ions and 85% of the somewhat larger Ge^{4+} ions go into tetrahedral sites. On the other hand the much larger Sn^{4+} ions greatly prefer the octahedral sites. In the garnets $Ca_3Fe_2Ge_3O_{12}$ and $Mn_3Fe_2Ge_3O_{12}$ there are indications of antiferromagnetism: in the former, the $1/\chi$ versus T curve becomes horizontal at low temperatures and in the latter there is a maximum in χ at about 6° K. In the compounds $Gd_3Co_2GaGe_2O_{12}$ and $Gd_3Ni_2GaGe_2O_{12}$ only paramagnetism was observed with a negative intercept of the $1/\chi$ versus T curve, wherea $Gd_3Mn_2GaGe_2O_{12}$ has previously been found to be ferrimagnetic. In comparison with the latter compound, it is surprising to find only a slight spontaneous magnetization of 0.1-0.2 μ_B in $Mn_3Fe_2Si_3O_{12}$.

539.2 : 538.

11894 MAGNETISM OF EUROPIUM GARNET. W.P.Wolf and J.H.Van Vleck.

Phys. Rev., Vol. 118, No. 6, 1490-2 (June 15, 1960).

The theoretical expressions for the magnetic moment of a trivalent europium ion in a molecular field arising from exchange are applied to Pauthenet's measurements on europium iron garnet. It is a good approximation to assume that the exchange interaction stems entirely from the coupling with the iron atoms, which greatly implifies the theory since the molecular field on the europium is hen an impressed one and does not have to be determined self-consistently. The calculated variation of the magnetization with emperature is in excellent accord with experiment. The magnitude f the exchange interaction is compared with that in the other rare arth iron garnets; it is almost exactly the same as in gadolinium ron garnet.

539.2 : 538.2

11895 CRYSTAL CHEMICAL AND MAGNETIC STUDIES OF GARNET SYSTEMS $\{YCa_2\}[M_2^{4+}](Fe_3)O_{12}-\{Y_3\}[Fe_2](Fe_3)O_{12}$, = Zr or Hf.

S.Geller, R.M.Bozorth, C.E.Miller and D.D.Davis.

. Phys. Chem. Solids, Vol. 13, No. 1-2, 28-32 (May, 1960).

A complete solid-solution range exists in the system $YCa_2\}[Zr_2](Fe_3)O_{12}-\{Y_3\}[Fe_2](Fe_3)O_{12}$. The Zr^{4+} ion is even larger han the Sn^{4+} ion and in this system apparently prefers only the octa- edral sites. The behaviour of the plot of $n_B(\infty, 0)$ versus composi- on is similar to that of the $Ca_3Fe_2Sn_3O_{12}-Y_3Fe_2Fe_3O_{12}$ system and orroborates the interaction model for garnets recently derived by illeo. A small spontaneous magnetization is observed in the garnets $YCa_2\}[Zr_2](Fe_3)O_{12}$ and $\{YCa_2\}[Zr_2](Me_{0.5}Fe_{2.5})O_{12}$, Me = Al and Ga, ndicating the establishment of magnetic sublattices among the tetra- edral sites. The garnet $\{YCa_2\}[Hf_2](Fe_3)O_{12}$ is readily formed. The f^{4+} ion, which is very nearly the same size as that of Zr^{4+}, also refers the octahedral site.

539.2 : 538.2 : 537.2

11896 MICROWAVE PROPERTIES OF NONSTOICHIOMETRIC POLYCRYSTALLINE YTTRIUM IRON GARNET.

.E.Seiden, C.F.Kooi and J.M.Katz.

. appl. Phys., Vol. 31, No. 7, 1291-6 (July, 1960).

An investigation was made of the microwave properties of non-toichiometric yttrium iron garnet ranging from 31% iron excess hrough stoichiometric to 12% yttrium excess. No ion substitution in he garnet lattice is observed. All material in excess of stoichio- etric proportions goes into ceramic second phases. The phases bserved are perovskite ($YFeO_3$) for yttrium excess, hematite Fe_2O_3) for iron-excess samples fired in oxidizing atmospheres, nd magnetite (Fe_3O_4) for iron-excess samples fired in neutral tmospheres. On the basis of the assumption that all excess material oes into the appropriate ceramic second phase, one may account for he behaviour of the saturation magnetization, spectroscopic splitting actor, and linewidth as a function of composition. It is found that the line- idth is strongly narrowed by the large magnetization as predicted y Geschwind and Clogston. The behaviour of the dielectric constant an be explained, at least qualitatively, by a theory of Wagner and illars which considers particles of one dielectric material imbedded a matrix of another. The behaviour of the dielectric loss tangent s not understood and cannot be accounted for by this theory.

539.2 : 538.2

11897 SUPEREXCHANGE INTERACTION IN FERRIMAGNETIC GARNETS AND SPINELS WHICH CONTAIN RANDOMLY NCOMPLETE LINKAGES.

M.A.Gilleo.

Phys. Chem. Solids, Vol. 13, No. 1-2, 33-9 (May, 1960).

The variation of saturation moment, Curie temperature and usceptibility of ferrimagnetic compounds as a result of substitution f nonmagnetic ions for magnetic ions, can be understood to a good pproximation on the basis of the random distribution of incomplete uperexchange interactions. The two premises required for the nderstanding are that: (1) a magnetic ion actively participates in rrimagnetism only if it interacts with two or more magnetic ions n different coordination and (2) the Curie temperature is determined y the number of complete interactions per active magnetic ion per rmula unit. The requirement that a magnetic ion interact with at ast two other magnetic ions in different coordination is implicit in e fact that ferrimagnetism is a cooperative phenomenon. Recent -ray diffraction and magnetic studies of the yttrium-iron–calcium- on-tin garnet system have provided the first firm basis for this nderstanding.

539.2 : 538.2

11898 CLASSICAL THEORY OF SPIN CONFIGURATIONS IN THE CUBIC SPINEL.

T.A.Kaplan.

. appl. Phys., Suppl. to Vol. 31, No. 5, 364S-365S (May, 1960).

It recently has been pointed out that the Yafet–Kittel triangular pin-configurations do not minimize the classical Heisenberg xchange energy in the cubic spinel. A perturbation calculation or determining the ground configuration is described, considering only nearest neighbour A–B and B–B interactions (J_{AB} and J_{BB}), and one spin-magnitude, S_A, for the A sites, one, S_B, for the B sites. The method consists of first determining the largest value, y_0, of $y = J_{BB}S_B/J_{AB}S_A$, for which the Néel configuration is stable with respect to sufficiently small spin-deviations. Solutions of the extremum equations as power series in $y-y_0$ (≥ 0) are sought such that the spin-deviations from the Néel configuration are small when $y-y_0$ is small. The detailed calculations lead to the following conclusions: (1) Equilibrium configurations exist which have, simultaneously, nonzero angles between spins on the A sites and between those on the B sites. (2) The ground state in the cubic spinel will probably be a long-range-ordered canted-spin arrangement, for at least some finite range of $y-y_0$. The significance of these conclusions in connection with experiments on $MnCr_2O_4$ and Mn_3O_4, and with Anderson's remarks concerning spin-configurations in spinels, is discussed.

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11899 HIGH-TEMPERATURE SUSCEPTIBILITY OF FERRIMAGNETIC SPINELS.

P.J.Wojtowicz.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 265S-266S (May, 1960).

Power series expansions of the susceptibility and its inverse in ascending powers of the exchange divided by the temperature have been obtained for ferrimagnetic spinels by using the methods of Rushbrooke and Wood. The Heisenberg form of exchange is assumed, and in this paper, interactions between neighbouring spins from dif different sublattices (A–B exchange) only are considered. The coefficients in the series are derived for arbitrary values of the spins on the two sublattices. The calculations have been carried out to terms including the fifth power of the exchange divided by the temperature; the molecular field theory by contrast is rigorously valid only to the first power term of its expansion. The explicit dependence of the Néel temperature on the spin values has also been deduced. The derived susceptibilities and Néel temperatures are compared to the results of earlier models. It is anticipated that these expansions will prove useful in the interpretation of accurate susceptibility data for the purpose of deriving meaningful values for the exchange interactions in the spinels.

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11900 FERROELECTRIC AND FERRIMAGNETIC PROPERTIES OF $(Ba_{6-2x}R_{2x})\ (Nb_{9-x}Fe_{1+x})O_{30}$.

P.H.Fang and R.S.Roth.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 278S (May, 1960).

Materials which possess properties, which strongly suggest both ferroelectricity and ferrimagnetism, are found in the systems $(Ba_{6-2x}R_{2x})\ (Nb_{9-x}Fe_{1+x})O_{30}$, where R is a trivalent rare earth ion and x can vary from 0 to 1. X-ray diffraction powder patterns indicate a single phase having the potassium tungsten bronze type structure also exhibited by $Ba_6Nb_8Zr_2O_{30}$. When R is Gd^{3+} and x is at a maximum for this system, the material appears to be both ferroelectric and ferrimagnetic at room temperature. The ferrimagnetism is indicated by the appearance of a remnant polarization and the ferroelectricity by the presence of a dielectric hysteresis loop. The magnetic susceptibility is of the order of 120 at room temperature and exhibits dispersion at frequencies near 20 Mc/s. Other properties of materials in these systems are discussed.

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11901 HIGH-FIELD MAGNETIZATION STUDY OF FERRIMAGNETIC ARRANGEMENTS IN CHROMITE SPINELS.

I.S.Jacobs.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 263S (May, 1960).

Brief note, substantially as follows. The observation of a differential susceptibility at high magnetic fields and low temperatures in spinel-type compounds has been shown to be useful for detecting noncollinear ferrimagnetic arrangements. Such an increase in net magnetization with field is not expected for the Néel model of tetrahedral A-site moments antiparallel to octahedral B-site moments. It is, however, expected for the triangular arrangements proposed by Yafet and Kittel in which the moments on one kind of site subdivide into two groups making angles with each other. The latter arrangements have frequently been suggested for chromium-containing spinels, usually on the basis of the observed anomalously low spontaneous magnetizations. Measurements of magnetization curves at 4.2°K in pulsed fields up to 140 kOe reveal high field susceptibilities in $MnFe_{2-t}Cr_tO_4$, $t > 0$; $CuCr_2O_4$; $FeCr_2O_4$; and $NiFe_{2-t}Cr_tO_4$, $t > 1$. These are interpreted as triangular ferrimagnetic arrangements and choices are made between alternative triangular models. In some cases the sign of the dominant anisotropy is suggested. Néel antiparallel ferrimagnetic arrays are confirmed for $MnFe_2O_4$ and for $NiFe_{2-t}Cr_tO_4$, $t < 1$. The present evidence for these conclusions is of a new and occasionally more direct type. A secondary conclusion is that particular care is required in the interpretation of magnetic data on powders of compounds with low crystal symmetry.

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11902 NEW MECHANISM OF ANISOTROPIC SUPEREXCHANGE INTERACTION. T.Moriya.
Phys. Rev. Letters, Vol. 4, No. 5, 228-30 (March 1, 1960).

The origin of an anisotropic interaction of the form $D \cdot [S_1 \times S_2]$, first suggested by Dzialoshinski (Abstr. 8286 of 1959), is discussed using Anderson's recent formalism (Abstr. 12464 of 1959). A perturbation calculation for the case of one electron per atom shows that this interaction is linear in the spin—orbit coupling and, although zero for crystals of high symmetry may be larger than the pseudo-dipolar coupling for crystals of low symmetry. The interaction is of the right order of magnitude to explain the magnetic moments of α-Fe_2O_3, $MnCO_3$, and CrF_3. A new spin arrangement is proposed for $CuCl_2.2H_2O$. D.M.Edwards

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11903 RIGHT-ANGLED SUPEREXCHANGE. T.N.Casselman and F.Keffer.
Phys. Rev. Letters, Vol. 4, No. 10, 498-500 (May 15, 1960).

Nearest neighbour coupling is shown to be of the same order as next nearest neighbour coupling due to the relatively large overlap between p_π anion and xy-like 3d cation orbitals. E.P.Wohlfarth

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11904 DEPENDENCE OF SPIN WAVE DISPERSION ON THE MAGNETIC STRUCTURE OF THE ANTIFERROMAGNETIC SPACE LATTICE. H.Cofta.
Acta phys. Polon., Vol. 16, No. 6, 481-3 (1957). In German.

Results for various cubic lattices on the method of Keffer, Kaplan and Yafet (Abstr. 4201 of 1953) are given. A.J.Manuel

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11905 METHOD OF APPROXIMATE CALCULATION OF MAGNETIZATION OF ISOTROPIC ANTIFERROMAGNETIC SUBSTANCES. Pu Fu-Cho [P'u Fu-ch'o].
Dokl. Akad. Nauk SSSR, Vol. 131, No. 3, 546-8 (March 21, 1960). In Russian.

Continuation of previous work (Abstr. 8064 of 1960) to obtain temperature dependent expressions for the magnetization of a cubic sample. The formulae are constructed for several ranges of applied magnetic field, especially in the vicinity of Néel's temperature. J.K.Skwirzynski

539.2 : 538.2

11906 SYMMETRY OF PIEZOMAGNETISM OF ANTIFERROMAGNETICS. B.A.Tavger.
Kristallografiya, Vol. 3, No. 3, 342-5 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 344-7 (May-June, 1958).

The possibility of piezomagnetism in antiferromagnetics is discussed on the basis of magnetic symmetry. Sixteen possible types of "tensor" of piezomagnetic moduli are found. It is shown that piezomagnetism is forbidden in those classes of magnetic symmetry which contain the operation of inversion of space and time coordinates and in classes $\bar{4}3m$, 43, m3m (T_d, O, O_h).

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11907 MAGNETO-ELECTRICAL EFFECT IN ANTIFERROMAGNETS. I.E.Dzyaloshinskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 3(9), 881-2 (Sept., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 3, 628-9 (March, 1960).

It is shown from symmetry considerations that the magneto-electric effect (first considered by Landau and Lifshits, "Electrodynamics of Continuous Media", 1958, in which a crystal placed in a constant electric — or magnetic — field exhibits a magnetic — or electric — moment proportional to the field) should occur in Cr_2O_3. S.A.Ahern

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11908 INDIRECT INTERACTION OF d-ELECTRONS OF THE TRANSITION METALS. II. ANTIFERROMAGNETISM.
B.V.Karpenko and A.A.Berdyshev.
Zh. eksper.teor. Fiz., Vol. 38, No. 3, 925-8 (March, 1960). In Russian.

Antiferromagnetics are considered within the framework of Vonsovskii's s—d-exchange model (1954). Energy of the spin waves is determined by perturbation theory methods. The possibility of existance of an antiferromagnetic state in the absence of direct d—d-exchange interaction is discussed. For Pt I, see Abstr. 11197 of 1959.

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11909 MECHANISM OF ANTIFERROMAGNETISM IN DILUTE ALLOYS. A.W.Overhauser.
J. Phys. Chem. Solids, Vol. 13, No. 1-2, 71-80 (May, 1960).

A mechanism for the antiferromagnetic ordering of a dilute paramagnetic solute in a metal is proposed and discussed in relation to the phenomena that occur in copper—manganese alloys. Long-range antiferromagnetic order results from a static spin-density wave in the electron gas of the metal. This new state of the gas is dynamically self-sustaining as a result of the exchange potentials arising from the spin-density distribution. The paramagnetic solute atoms are then oriented by their exchange interaction with the spin-density wave. The resulting interaction energy more than compensates the increase in energy associated with the formation of the spin-density wave. The theory predicts correctly the magnitude and concentration-dependence of the critical temperature, the anomalous low-temperature specific heat and the anomalous electrical and magnetic properties of the alloys.

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11910 MECHANISM OF ANTIFERROMAGNETISM IN CHROMIUM. A.W.Overhauser and A.Arrott.
Phys. Rev. Letters, Vol. 4, No. 5, 226-7 (March 1, 1960).

An experiment is proposed which may distinguish between three mechanisms of antiferromagnetism in Cr. The method proposed is to cool a single crystal through the Néel point to a low temperature in a large magnetic field parallel to a (100) crystal axis, and then to study the relative intensities of six magnetic reflection spots observed in neutron diffraction experiments (see Abstr. 1816 of 1960). D.M.Edwards

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11911 PIEZOMAGNETISM IN ANTIFERROMAGNETIC COBAL AND MANGANESE FLUORIDES. A.S.Borovik-Romanov
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1088-98 (April, 1960). In Russian.

A special torsion magnetic balance, with a press, was constructed for detection of piezomagnetism. In accordance with theoretical predictions, piezomagnetic moments m^p_e appeared in CoF_2 and MnF_2 on application of shearing stresses σ_{ik}. The piezomagnetic moduli were ~ 10^{-3} $G(kg/cm^2)^{-1}$ for CoF_2 and ~ 10^{-5} $G(kg/cm^2)^{-1}$ for MnF_2. A detailed thermodynamic analysis of the results was carrie out. Along with a piezomagnetic moment perpendicular to the direction of the sublattice magnetization, equivalent to the well-known weak transverse ferromagnetism, a moment was observed which wa parallel to the sublattice magnetization and equivalent to the hithert unobserved weak longitudinal ferromagnetism.

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11912 ANTIFERROMAGNETISM OF IRON IN FACE-CENTERE CRYSTALLINE LATTICE AND THE CAUSES OF ANOMALIES IN INVAR PHYSICAL PROPERTIES.
E.I.Kondorsky and V.L.Sedov.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 331S-335S (May, 1969).

The anomalies of electrical and magnetic properties in Invars a low temperatures and the fact that these anomalies are observed in Fe—Ni alloys with the nickel content ranging from 30-40 are explained on the grounds of an assumption that the exchange integral o electrons of neighbouring ions of iron in a face-centred lattice is negative which entails a "latent" antiferromagnetism in the Invars. This assumption is founded on experimental data obtained by author and proving that in an Fe alloy with a face-centred lattice, stable at low temperatures thanks to the presence of chromium and nickel alloying elements, an antiferromagnetic transformation occurs. The paper presents results of investigation of the influence of pressure upon the magnetic saturation σ_s and the residual resistivity ρ_0 of iron, nickel and Fe—Ni alloys at low temperatures. It is shown tha the values $K_\sigma = (1/\sigma_s)(\Delta\sigma_s/\Delta P)$ and $K_\rho = (1/\rho_0)(\Delta\rho/\Delta P)$ in Invar alloys at low temperatures and other Fe—Ni alloys; the ratios K_ρ/K_σ are approximately equal to the ratios $(1/\rho_0)(\Delta\rho_0/\Delta H)/(1/\sigma_s) \times (\Delta\sigma_s/\Delta H)$, which is in agreement with the conclusions of the suggest theory.

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11913 NEUTRON DIFFRACTION INVESTIGATION OF THE $Fe_{1-\delta}S$ SYSTEM.

J.T.Sparks, W.Mead, A.J.Kirschbaum and W.Marshall.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 356S-357S (May, 1960).

The intensity of the purely magnetic (001) reflection has been nvestigated as a function of temperature for $Fe_{1-\delta}S$ samples with δ = 0.02, 0.066, 0.099 and 0.107. Samples from the antiferromagnetic α' phase, δ = 0.02, exhibit a spin reorientation at a temperature corresponding closely to that at which the susceptibility anomaly occurs 125°C). Preliminary measurements on a stoichiometric sample, δ = 0, suggest that for this composition, two distinct spin reorienta- ions occur, one at 140°C corresponding to the abrupt change in susceptibility and the second at 160°C. The presence of a small 001) reflection at room temperature in the α'-phase samples, and he appearance of the X-ray powder diffraction photographs suggest hat a mixed phase region may exist below the α' transition. Quenching from above the α' transition produces samples which show no room temperature peak, and whose X-ray patterns indicate only a ingle phase. An examination of the (001) reflection of samples for which δ = 0.066, 0.099 and 0.107, suggests that for these compositions he spins lie in the hexagonal planes from room temperature to the Néel temperature, 320°C. No anomalies were observed for δ = 0.066 at the α'' transition or in the γ region. Also no evidence of disorder ccurring in the spin system below T_n was observed with either = 0.099 or δ = 0.107.

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11914 ANTIFERROMAGNETIC $FeVO_3$.

C.R.Berry and C.M.Combs.
. appl. Phys., Vol. 31, No. 6, 1130 (June, 1960).

Reports measurements of the lattice constants of solid solutions f Fe_2O_3 and $FeVO_3$ which are shown to have the disordered ilmenite tructure and to be non-ferromagnetic. E.P.Wohlfarth

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11915 MAGNETIC PROPERTIES OF MANGANESE COPPER ALLOYS.

R.Street.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 310S-317S (May, 1960).

The magnetic properties of the Mn—Cu alloy system have been nvestigated by using a number of experimental techniques. Long ange antiferromagnetic order occurs in alloys of high Mn concen- ration; the disappearance of ordering is associated with a marten- itic transformation from face centred tetragonal to face centred ubic. By extrapolation of the experimental results it is possible to erive the Néel temperature and magnetic moment of Mn ions in ure f.c.t. γ-Mn as approximately 390°K and 2.4 ± 0.1 μ_B, respec- vely. At lower Mn concentrations, it is likely that short range ntiferromagnetic ordering occurs and in addition at sufficiently low emperatures weak ferromagnetic behaviour associated with high oercive force becomes apparent. These results and possible inter- retations of them are discussed.

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11916 EVIDENCE FOR AN ANTIFERROMAGNETIC-FERRIMAGNETIC TRANSITION IN Cr-MODIFIED Mn_2Sb.

J.Swoboda, W.H.Cloud, T.A.Bither, M.S.Sadler and H.S.Jarrett.
hys. Rev. Letters, Vol. 4, No. 10, 509-11 (May 15, 1960).

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11917 ANTIFERROMAGNETIC STRUCTURE AND DOMAINS IN SINGLE CRYSTAL NiO.

W.L.Roth and G.A.Slack.
. appl. Phys., Suppl. to Vol. 31, No. 5, 352S-353S (May, 1960).

Single crystals of NiO have been annealed and stressed at room emperature to sweep out twin boundaries. Neutron diffraction and otational torque studies have been made on a crystal which had only .3% of the twin orientation. The ferromagnetic sheet structure riginally proposed in which the atomic moments lie in (111) planes s found to be correct. The anisotropy in the (111) plane is extremely mall and at low fields the spins in the ferromagnetic sheet are ocked in domains and the susceptibility is nearly isotropic. Rotation the spins in (111) takes place at fields above 2400 Oe.

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11918 MAGNETOSTRICTION OF ANTIFERROMAGNETIC NICKEL MONOXIDE.

K.P.Belov and R.Z.Levitin.
h. eksper. teor. Fiz., Vol. 37, No. 2(8), 565-6 (Aug., 1959). In ussian. English translation in: Soviet Physics—JETP (New York), ol. 37(10), No. 2, 400-1 (Feb., 1960).

Polycrystalline NiO was studied. The mass susceptibility and Curie point were found to agree with earlier determinations. The transverse magnetostriction (H = 14 200 Oe) was found to be negative and to decrease monotonically in magnitude on approach to the Curie point. At room temperature the longitudinal magnetostriction is positive and both this and the transverse effect have a critical field (H_c ~ 5000 Oe) below which the magnetostriction is zero. The magnetostriction in antiferromagnetic materials may be dependent upon the presence of a domain structure and the critical field connected with the existence of a coercive force of the order of 10^4 Oe. Young's modulus was found to decrease on the application of a strong magnetic field. F.E.Hoare.

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11919 NEUTRON DIFFRACTION INVESTIGATION OF THE MAGNETIC STRUCTURE OF NICKEL OXIDE.

H.A.Alperin.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 354S-355S (May, 1960).

A neutron diffraction study of nickel oxide was performed utilizing single crystal samples to investigate the magnetic structure. The results indicate the structure to have a single magnetic axis lying in a (111) plane, but within this plane there are domains such that the directions of the moments of these domains are distributed symmetrically. To fit the data required an effective spin value for the Ni^{++} atom of 0.8 and an isotropic form factor $\exp[-6(\sin\theta/\lambda)^2]$.

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11920 BAND THEORY OF SUPEREXCHANGE INTERACTION.

J.Kondo.
Progr. theor. Phys., Vol. 18, No. 5, 541-51 (Nov., 1957).

A spin-dependent energy of the NiO crystal is derived. One-electron orbits of the Bloch type were used as linear combinations of 2p- and 3d-orbits of O^{2-} and Ni^{2+} ions. For the antiferromagnetic state the ordered antiparallel spin arrangement was assumed and then two alternate bands corresponding to α and β spin Ni^{2+} ions are mixed. The energy difference between the parallel and antiparallel spin state is formulated. Rough numerical estimation, using s-orbits instead of 3d-orbits, shows that the mixing of two alternate bands plays an important role in the superexchange interaction.

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11921 MAGNETIC SUSCEPTIBILITIES OF SINGLE CRYSTAL $NiCl_2 \cdot 6H_2O$ AND $CoCl_2 \cdot 6H_2O$ AT LOW TEMPERATURES.

R.B.Flippen and S.A.Friedberg.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 338S-339S (May, 1960).

The magnetic susceptibilities of single crystal $NiCl_2.6H_2O$ and $CoCl_2 \cdot 6H_2O$ have been measured down to 1.3°K for various orientations. The occurrence of antiferromagnetism in $CoCl_2 \cdot 6H_2O$ below ~2.3°K is confirmed as is the anisotropy of the g-factor of the Co^{++} ion over the whole range. It is concluded that $NiCl_2 \cdot 6H_2O$ is antiferromagnetic in the helium region and that the temperature-independence of the powder susceptibility here is caused by the fact that $\chi_\perp$ rises as T falls below T_N.

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11922 THE ANTIFERROMAGNETIC STRUCTURE OF NiMn.

J.S.Kasper and J.S.Kouvel.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 231-8 (Oct., 1959).

The ordered alloy NiMn is found to be an antiferromagnet with a very high Néel temperature (> 600°K) on the basis of neutron-diffraction and magnetic-susceptibility measurements. The magnetic unit cell has lower symmetry than the tetragonal chemical cell; the moment directions are normal to the c-axis. The moments of nearest-neighbour manganese atoms (in planes normal to the c-axis) are antiparallel to each other. A detailed discussion of possible magnetic models is given; for all of them, $\mu_{Mn} = 4.0 \pm 0.1$. It is inferred that μ_{Ni} is probably much less than 0.6. The magnetic anisotropy is discussed and compared to that of γ-manganese.

Magnetic Resonances

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11923 DETERMINATION OF THE g-FACTOR FROM THE COMPARISON OF THE FREQUENCIES OF THE PARAMAGNETIC AND CYCLOTRON RESONANCES OF ELECTRONS.

V.N.Lazukin.
Dokl. Akad. Nauk SSSR, Vol. 131, No. 5, 1064-6 (April 11, 1960).
In Russian.

A simple visual method of observing a cyclotron resonance absorption line on an oscillograph screen is developed. The apparatus is next arranged to give a paramagnetic electron resonance absorption line in anthracite. By tuning the frequency of the microwave generator, the paramagnetic resonance line is displaced to the position previously occupied by the cyclotron resonance line. The new frequency is measured. The difference of the frequencies is equal to $(g - 2)\ eH/4\pi mc$, from which, after estimating errors, it is found that $g = 2.00484 \pm 0.00220$. N.Davy

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11924 GYROMAGNETIC RATIOS OF Fe AND Ni.

G.G.Scott.

Phys. Rev., Vol. 119, No. 1, 84-5 (July 1, 1960).

It is shown that the previously observed decrease in the value of g' for weakly magnetized specimens of Fe and Ni (Abstr. 8922 of 1955, 494 of 1956), was caused by a systematic error in the measurement of magnetic moment. Recent experiments on these two metals indicate g' values of 1.919 ± 0.002 for Fe and 1.835 ± 0.002 for Ni.

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11925 RECENT DEVELOPMENTS IN FERROMAGNETIC RESONANCE AT HIGH POWER LEVELS.

E.Schlömann, J.J.Green and U.Milano.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 386S-395S (May, 1960).

The influence of inhomogeneities on the saturation of the ferromagnetic resonance is investigated. In the region of moderate power levels, the susceptibility at resonance χ'' varies linearly with the square of the r.f. field h. The magnitude of the slope $\partial\chi''/\partial h^2$ depends on the nature of the dominant scattering mechanism. If the uniform mode scatters primarily to spin waves of very large wavelength, the slope should be negative. Scattering to spin waves of short wavelength gives a positive contribution to the slope and can lead to a reversal of the sign. The theoretical predictions agree with measurements at X band on various polycrystalline garnets and ferrites. At very high power levels the opening angle of the precessing magnetization vector approaches a limiting value, which is related to the "line width" ΔH_k of z directed spin waves having the same frequency as the uniform mode. Experiments on single crystals and polycrystals of rare earth substituted garnets show that ΔH_k increases approximately linearly with the rare earth content. The materials investigated contain Gd, Yb, Er, Sm, Dy, Ho, or Tb and for a given ratio of substitution ΔH_k increases in that order. The line width ΔH_k of z directed spin waves is found to be approximately proportional to the line width ΔH of the uniform mode as measured in single crystals. Experimental results on cobalt and zinc substituted nickel ferrite are reported. ΔH_k increases linearly with the cobalt content. For the nickel—zinc ferrites with a large magnetic moment the saturation curve (χ'' versus h^2) measured at X band shows a maximum well below the initial onset of nonlinearity. A theoretical explanation for this extraordinary behaviour is given. A new nonlinear effect arising from spin wave instability in a microwave magnetic field applied parallel to the d.c. field has been observed. Spin waves which propagate in directions perpendicular to the d.c. field are most susceptible to this instability. The observed variation of the critical r.f. field strength agrees well with the theoretical predictions. It indicates that the spin-wave line-width increases with increasing wave number and decreasing angle between propagation direction and d.c. magnetic field.

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11926 MAGNETIC RESONANCE IN RHOMBOHEDRAL WEAKLY FERROMAGNETIC SUBSTANCES.

E.A.Turov and N.G.Guseinov.

Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1326-31 (April, 1960). In Russian.

Resonance frequencies for rhombohedral weakly ferromagnetic crystals of the α-Fe_2O_3 or $MnCO_3$ type were computed on the basis of Dzyaloshinskii's concept of the nature of weak ferromagnetism. The effect of anisotropy in the basis plane was taken into account and the dependence of resonance frequencies on the magnitude and direction of the magnetizing field was derived. The theoretical formulae were compared with the experimental data for α-Fe_2O_3.

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11927 IONIC ORDERING EFFECTS IN THE FERROMAGNETIC RESONANCE OF LITHIUM FERRITE MONOCRYSTALS.

A.D.Schnitzler, V.J.Folen and G.T.Rado.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 348S-349S (May, 1960).

Ferromagnetic resonance experiments on ordered and disordered lithium ferrite monocrystals are reported. The resonance line width ΔH, the g factor, and the magnetocrystalline anisotropy constants K_1 and K_2 were measured at temperatures ranging from $300°$ to $4°$ K. Before an influence of ordering on ΔH could be observe it was necessary to reduce drastically several spurious effects. The included a large and strongly anisotropic ΔH, which was attributed to a plastic deformation in a thin layer underlying the sample surfac After proper preparation of the samples, it was found that at all temper tures and crystallographic angles at which measurements were made the value of ΔH is either increased or relatively unchanged as a result of long-range cation ordering. It is concluded that in lithium ferrite, at least, spin wave scattering resulting from cation disorder is not the dominant source of linewidth. The observations include a large peak of ΔH obtained in the [110] direction of the ordered samples at low temperatures, and a low value of ΔH (3 Oe) obtained in the [111] direction of the disordered samples at $4°$ K.

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11928 FERROMAGNETIC RESONANCE IN POLYCRYSTALLIN FERRITES USING CIRCULARLY POLARIZED RADIATION.

R.J.Zeender and E.Schlömann.

J. appl. Phys., Vol. 31, No. 6, 1112-16 (June, 1960).

If the saturation magnetization is much smaller than the anisotropy field, the resonance curves observed in polycrystalline ferrites have a well-defined structure with several peaks or shoulders (see for example Abstr. 8868 of 1958). The use of circularly polarized radiation facilitates a clear identification of the peaks. In cubic materials the central peak (arising from grains which have a [100] direction aligned with the d.c. field) is partially excited by both senses of circular polarization, whereas the two outer peaks or shoulders are excited only by the positive sense of circular polarization. Experimental results obtained in the compensation region of the nickel ferrite-aluminate systems agree well with the theoretical predictions. These results rule out the possibili that the additional absorption peaks are due to an exchange resonanc

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11929 TEMPERATURE DEPENDENCE OF FERROMAGNETIC RESONANCE IN YTTRIUM FERRITE GARNETS.

L.A.Malevskaya and G.M.Nurmukhamedov.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1600-1 (May, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1137-8 (Nov., 1959).

Measurements of spontaneous magnetization, width of resonanc line and g-factor have been made for polycrystalline yttrium ferrite garnets in which the Fe^{3+} ions have been partly replaced by Al^{3+} and Cr^{3+} ions. The decrease of ΔH and σ with temperature is more gradual for the substituted ferrites than for the stoichiometric one and this was thought to be due to fluctuations in the exchange interaction arising from the random distribution of Al^{3+} and Cr^{3+} ions. Far from the Curie point ΔH is proportional to $\sqrt{\sigma_s}$ in agreement with theory (Abstr. 2996 of 1956). D.J.Oliver

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11930 CALCULATION OF THE WIDTHS OF FERRIMAGNETIC ABSORPTION LINES IN THE CASE OF SPIN WAVES OF NON-NEGLIGIBLE AMPLITUDE.

P.E.Seiden.

C.R. Acad. Sci. (Paris), Vol. 250, No. 14, 2530-2 (April 4, 1960).
In French.

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11931 RESONANCE MEASUREMENTS IN MAGNETIC GARNETS.

G.P.Rodrigue, H.Meyer and R.V.Jones.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 376S-382S (May, 1960).

The effective g value, anisotropy constants, and line widths of single crystals of YIG, GdIG, SmIG, HoIG, ErIG, and YbIG have been measured over a range of temperatures from $1.5°$ K, to $550°$ K by ferrimagnetic resonance. The temperature dependence of K in both YIG and GdIG is satisfactorily represented by the model of an individual ion subject to a crystalline field in addition to a Weiss molecular field. The g values of HoIG and ErIG appear to be in goo agreement with the estimations of Kittel et al. for a ferrimagnetic system with one sublattice strongly damped. It has been found that SmIG and YbIG do not follow the predictions of the Kittel model, sinc different relative strengths of exchange and relaxation interactions seem to be involved.

539.2 : 538.27

11932 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. IIIA.

B.Bölger.

Proc. K. Ned. Akad. Wetensch. B, Vol. 63, No. 1, 51-67 (1960).

The theory and experimental results relevant to this work ave been reported earlier (see Abstr. 4518-20 of 1960). Parts IA and IIIB (see following abstract) describe measurements of , the molar power transfer constant

$$\frac{d\,P_{ext}}{d(P_{ext}/P_m)}$$

ade on a variety of paramagnetic salts in the frequency range entred on 9.4 kMc/s, and over a temperature range down to liquid elium. This part is concerned with the measurements on single rystals of CrK alum, and the CuK and $CuNh_4$ Tutton salts. The esults are reported in considerable detail and compared with those btained using other techniques, particularly non-resonant relaxaon techniques. S.A.Ahern

539.2 : 538.27

11933 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. IIIB.

.Bölger.
roc. K. Ned. Akad. Wetensch. B, Vol. 63, No. 1, 68-79 (1960).

See preceding abstract. This part is concerned with the measrements on single crystals of $CuSO_4.5H_2O$, $CuK_2Cl_4.2H_2O$, $u(NH_4)_2Cl_4.2H_2O$, $Mn(NH_4)_2(SO_4)_2.6H_2O$ and $Co(NH_4)_2(SO_4)_2.6H_2O$. The esults are reported as before. S.A.Ahern

539.2 : 538.27

11934 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. IIIC.

.Bölger.
roc. K. Ned. Akad. Wetensch. B, Vol. 63, No. 1, 80-91 (1960).

See preceding abstracts. This paper reports the results of elaxation time measurements obtained using the pulse-saturation echnique and by experiments on masers. The measurements have een made on samples of synthetic ruby and of chromium doped $_3Co(CN)_6$. Using ruby, measurements have been made with a gnal frequency of 1430 Mc/s and pump frequencies of 8500 Mc/s d 10 700 Mc/s, in the temperature range up to 30° K. The maser easurements on the $K_3Co(CN)_6$:Cr were made with a signal freency of 1420 Mc/s and a pump frequency of 3850 Mc/s in e temperature range up to 20° K. See following abstracts. S.A.Ahern

539.2 : 538.27

11935 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. IVA.

.Bölger.
roc. K. Ned. Akad. Wetensch. B, Vol. 63, No. 2, 157-71 (1960).

The results reported in previous papers in this series (see preeding abstracts) are discussed in detail in Parts IVA and IVB ee following abstract). In this part the discussion is concerned ith the relation between the relaxation time T_1, and the molar power ansfer constant η, and in particular the effect of phonon interacon and spin-spin interactions. S.A.Ahern

539.2 : 538.27

11936 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. IVB.

.Bölger.
roc. K. Ned. Akad. Wetensch. B, Vol. 63, No.2, 172-84 (1960).

A continuation of the previous part (see preceding abstract), in hich the discussion is concerned with the influence of an inhomoeniously distributed power transfer constant. The series is sumarized, and the possible course of future work considered. S.A.Ahern

539.2 : 538.27

11937 PARAMAGNETIC RESONANCE SPECTRA OF IMPURITIES IN CALCIUM FLUORIDE. M.Dvir and W.Low.

roc. Phys. Soc., Vol. 75, Pt I, 136-8 (Jan., 1960).

Some results are reported which differ significantly from similar easurements made by Baker, Hayes and Jones (Abstr. 6267 of 1960). ectra are described arising from Er^{3+}, Ce^{3+}, Co^{2+} and Eu^{2+}. The e^{3+} spectrum is of particular interest as the ground state is a Γ_8 artet. J.M.Baker

539.2 : 538.27 : 535.33

11938 PARAMAGNETIC AND OPTICAL SPECTRA OF YTTERBIUM IN THE CUBIC FIELD OF CALCIUM LUORIDE. W.Low.

hys. Rev., Vol. 118, No. 6, 1608-9 (June 15, 1960).

The paramagnetic resonance spectrum of Yb^{3+} in CaF_2 was observed at 20° K and 3 cm wavelength. The spectrum is described by a cubic spin Hamiltonian $\mathcal{H} = g\beta H.S + AS.I$ with $g = 3.426 \pm 0.001$, $S = \frac{1}{2}$, $A^{171} = (886.5 \pm 1.5) \times 10^{-4}\ cm^{-1}$, $A^{173} = (243.2 \pm 0.4) \times 10^{-4}\ cm^{-1}$, $I^{171} = \frac{1}{2}$, $I^{173} = \frac{5}{2}$. The ratio of magnetic moments is $\mu^{173}/\mu^{171} = 1.374_9 \pm 0.005$. The optical spectrum shows lines of 9774, 9770, 9763 Å, and more diffuse and unresolved bands at 9080 and 12730 A. The paramagnetic spectrum is explained as arising from the Γ_7 doublet. The other levels are removed by at least a few cm^{-1} leading to an isotropic g value of 3Λ or 24/7 for the lowest Γ_7 level.

539.2 : 538.27

11939 TRANSITION PROBABILITIES FOR THE EXCITED STATE $d\epsilon^3\ {}^2\Gamma_3$ OF Cr^{3+}. A.M.Clogston.

Phys. Rev., Vol. 118, No. 5, 1229-30 (June 1, 1960).

Geschwind et al. (Abstr. 4508 of 1960) have observed transitions between the Zeeman components of the excited metastable state $d\epsilon^3\ {}^2\Gamma_3$ of trivalent chromium present as a dilute impurity in Al_2O_3. In first order the transitions are forbidden. In third order a number of processes give rise to a transition probability and predict $g_\perp = 0.1$, consistent with the experimental observations. The magnetic moment associated with the transition is shown to rotate opposite to the usual sense.

539.2 : 538.27

11940 SPIN—LATTICE RELAXATION IN CHROMIUM CORUNDUM. A.A.Manenkov and A.M.Prokhorov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 729-3 (March, 1960). In Russian.

Spin—relaxation of Cr^{3+} ions in corundum single crystals was studied at temperatures of 290, 77 and 4.2° K and at various magnetic dilutions. Continuous saturation of resonance paramagnetic absorption at a frequency of 9375 Mc/s was employed. The spin—lattice relaxation times T_1 determined from the saturation of the lines of various electronic transitions were found to depend on the degree of magnetic dilution. T_1 varies between 10^{-5}-10^{-6} sec for T = 77° K and between 10^{-2}-10^{-5}sec for T = 4.2° K when the Cr^{3+} ion concentration increases with respect to that of the Al^{3+} ions from $\sim 5 \times 10^{-4}$ to 6×10^{-3}. For a sample with a large magnetic dilution the magnitude of T_1 at T = 4.2° K depends on the saturating power, increasing with increase of the latter. The anomalous nature of spin—lattice relaxation in chromium corundum is probably connected with energy transfer processes from the spin system to the thermostat (liquid helium) such as spin—phonon interaction, including phonon diffusion processes and transfer of energy from the lattice to the thermostat.

539.2 : 538.27

11941 INVESTIGATION OF THE LINE WIDTH AND PROFILE IN THE PARAMAGNETIC RESONANCE SPECTRUM OF THE Cr^{+++} ION IN CORUNDUM SINGLE CRYSTALS.

A.A.Manenkov and V.B.Fyodorov.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1042-6 (April, 1960). In Russian.

The broadening of the fine-structure lines in the paramagnetic resonance spectrum of Cr^{+++} in Al_2O_3 single crystals was studied. The width and profile of the lines were investigated for various electron transitions and various concentrations of chromium. A qualitative interpretation of the experimental results can be made on the basis of the dipole broadening mechanism and the assumption of local inhomogeneity of the crystal electric field. A quantitative comparison with the dipole broadening theory does not yield satisfactory results.

539.2 : 538.27

11942 PARAMAGNETIC RESONANCE SPECTRUM OF MANGANESE IN CORUNDUM. W.Low and J.T.Suss.

Phys. Rev., Vol. 119, No. 1, 132-3 (July 1, 1960).

The paramagnetic resonance spectrum of Mn^{2+} in Al_2O_3 was measured at 3 cm. The spectrum can be expressed in a spin Hamiltonian with trigonal symmetry with the following parameters: $g \ = 2.0017 \pm 0.001$, $g \ = 2.000 \pm 0.002$, $D = +194.2 \pm 1$, $a - F = +21.9 \pm 0.6$, $A = -79.6 \pm 0.5$, $B = -78.8 \pm 0.8$ in units of $10^{-4}\ cm^{-1}$.

539.2 : 538.27

11943 DYNAMICAL NATURE OF THE JAHN—TELLER EFFECT AND ITS INFLUENCE ON THE PARAMAGNETIC RESONANCE OF Cu^{2+}. V.I.Avvakumov.

Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 1017-25 (Oct., 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 57(10), No. 4, 723-9 (April, 1960).

Copper complexes $Cu^{2+} \times_6$ differ from other paramagnetic complexes by an infinite set of geometries (within a certain manifold) which corresponds, in the first approximation, to the energy minimum. The crystal field theory is employed to relate the complex geometry with the electron density distribution in the Cu^{2+} ion. "Geometry degeneracy" leads to the result that the density may experience finite (permanent) distortions. It is demonstrated that the changes in the "crystal" field which correspond to these distortions should lead to oscillations of the electron cloud of the Cu^{2+} ion relative to the nucleus. The influence of interactions which yield partial stabilization of the complex is also considered. It is shown that even when these interactions are taken into account the electron cloud continues to oscillate although its frequency is smaller and depends on the mass of X atoms. The influence of the effect on the hyperfine structure and g-factors in free complexes is analysed.

539.2 : 538.27

11944 PROPOSAL FOR AN ELECTRON SPIN RESONANCE EXPERIMENT OF S-STATE IONS UNDER HIGH HYDROSTATIC PRESSURE. H.Watanake.
Phys. Rev. Letters, Vol. 4, No. 8, 410-11 (April 15, 1960).

The author has shown [Progr. theor. Phys., Vol. 18, No.4, 405-20 (Oct., 1957)] that a crystal field model gives the cubic field splitting parameter a for Mn^{2+} proportional to the square of the cubic crystal field. Hence a should be proportional to the inverse tenth power of the interatomic distances and should always be positive. The values of a measured in various materials are all positive and have the right order of magnitude but it is difficult to confirm the inverse tenth power dependence. The author proposes measurements under hydrostatic pressure to confirm this dependence on interatomic distance directly. J.M.Baker

539.2 : 538.27

11945 PARAMAGNETIC ABSORPTION OF ROTATION OF PLANE OF POLARIZATION FOR CERTAIN SALTS IN THE MICROWAVE BAND. A.I.Kurushin.
Zh. eksper. teor. Fiz., Vol. 37, No. 1(7), 297-8 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 209-10 (Jan., 1960).

The angle of rotation β of the plane of polarization of a microwave beam is proportional to $(\chi''_{\perp} - \chi''_{\parallel})$, where $\chi''_{\perp}$ and $\chi''_{\parallel}$ are the imaginary parts of the magnetic susceptibility for perpendicular and parallel fields. These latter quantities have been measured at 9150 Mc/s for a variety of paramagnetic salts as a function of an applied steady magnetic field H_0. From these results the dependence of β on H_0 was obtained. The results for $MnCl_2 \cdot 4H_2O$ do not agree with a previous determination. D.J.Oliver

539.2 : 538.27

11946 THE GROUND STATES OF BOUND PARAMAGNETIC RARE-EARTH IONS IN AN EXTERNAL MAGNETIC FIELD. N.V.Afanas'eva.
Optika i Spektrosk., Vol. 8, No. 1, 8-12 (Jan., 1960). In Russian.

Discusses a crystalline field with tetragonal symmetry. The matrix elements of the crystal field potential are calculated allowing for interaction between the states when an external magnetic field is applied. The spin Hamiltonian coefficients are determined for ions of all rare earths. The energy levels which may give rise to paramagnetic resonance absorption lines are discussed. The results obtained agree quite satisfactorily with the available experimental data. A.Tybulewicz

539.2 : 538.27

11947 FINE STRUCTURE IN THE PARAMAGNETIC RESONANCE SPECTRUM OF NATURAL SAPPHIRE. V.M.Vinokurov, M.M.Zaripov and N.R.Yafaev.
Zh. eksper. teor. Fiz., Vol. 37, No. 1, 312-13 (July, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 1, 220-1 (Jan., 1960).

The fine structure is thought to be due to the presence of Fe^{3+} ions. This view is confirmed by comparing the values of the constants in the Hamiltonian deduced in these experiments with values obtained for Fe^{3+} ions artificially introduced in Al_2O_3. D.J.Oliver

539.2 : 538.27

11948 PARAMAGNETIC RESONANCE ABSORPTION OF NICKEL IN SAPPHIRE. S.A.Marshall and A.R.Reinberg.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 336S-337S (May, 1960).

A paramagnetic resonance absorption spectrum which is in excess of that due to trivalent chromium and iron has been observed in sapphire single crystal. The spectrum is interpreted as being due to transitions between fine structure energy states of divalent nickel. Best fit constants to the spin Hamiltonian, obtained at room temperature, are given by $D = (1.385 \pm 0.002)\,cm^{-1}$, $g_{\parallel} = 2.196 \pm 0.004$, and $g_{\perp} = 2.187 \pm 0.004$. Measurements made by progressive saturation of the resonance lines at 77°K give an average spin-lattice relaxation time of 6×10^{-6} sec.

539.2 : 538.27

11949 ELECTRON PARAMAGNETIC RESONANCE IN SILVER HALIDES CONTAINING BIVALENT ANIONS. I.Ebert.
Z. Naturforsch., Vol. 15a, No. 4, 279-81 (March, 1960). In German.

Resonances are detected, after illumination, in cooled mixed crystals of silver halide (chloride or bromide) with silver sulphide, selenide or telluride. The g-values depend on the nature of the added substance, and exceed the free-electron value by amounts proportional to the predicted spin—orbit coupling constants of S^-, Se^- and Te^-, to which ions the resonance is shown to be due. The removal of degeneracy of the ground states of S^-, Se^- and Te^- is discussed in terms of non-cubic components in the crystal field and the Jahn—Teller effect. Causes of line-width are also discussed, the main factor being probably hyperfine exchange with the nuclei of silver or halogen. J.Sheridan

539.2 : 538.27

11950 THEORY OF THE ELECTRON SPIN RESONANCE OF F-CENTRES IN CRYSTALS WITH THE NaCl STRUCTUR L.A.Shul'man.
Zh. eksper. teor. Fiz.,Vol. 36, No. 6, 1709-16 (June, 1959). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 36(9), No. 6, 1217-22 (Dec., 1959).

Two models of the F-centre are used, the de Boer and the Hilsch—Pohl models. The wave-function of the ground state is derived for both models, using the molecular orbital approximation. The hyperfine interaction of the F-centre electron with the magnetic moments of the nuclei in the first and second coordination spheres is considered. The coupling constants in the corresponding spin Hamiltonian are calculated. The paramagnetic resonance absorption of radio frequencies by F-centres is examined. The shape and width of the absorption band are obtained. For the KCl crystal, comparison comparison with the experimental data shows agreement between theory and experimental results.

539.2 : 538.27

11951 ELECTRON PARAMAGNETIC RESONANCE OF Fe^{3+} IN TiO_2 (RUTILE). D.L.Carter and A.Okaya.
Phys. Rev., Vol. 118, No. 6, 1485-90 (June 15, 1960).

Paramagnetic resonance was observed from 2 to 110 kMc/s in Fe^{3+} -doped single crystals of rutile at 78°, 4.2° and 1.4°K. The rather large zero-field splittings measured between the three doublets are 43.3 ± 0.1 and 81.3 ± 0.1 kMc/s. The derived constants for the spin Hamiltonian:

$$\mathcal{H} = g\,\vec{H}\cdot\vec{S} + D(S_z^2 - 35/12) + E(S_x^2 - S_y^2) + \\ + (a/6)(S_x^4 + S_y^4 + S_z^4 - 707/16) + \\ + (7/36)F[S_z^4 - (95/14)S_z^2 + 81/16]$$

are $D = 20.35 \pm 0.1$ kMc/s, $E = 2.21 \pm 0.07$ kMc/s, $a = 1.1 \pm 0.2$ kMc/s, $F = -0.5 \pm 0.3$ kMc/s, $g = 2.000 \pm 0.005$. The average line width is 35 Mc/s for 2×10^{19} spins per cm^3, and the average spin—lattice relaxation time T_1 at T = 1.4°K is 4 msec. T_1 still has a very slow inverse temperature dependence even at T = 78°K. An increase in sensitivity over metal-walled cavity spectrometers was achieved by using the pieces of Fe-doped rutile as the microwave resonators.

539.2 : 538.27 : 537.312

PARAMAGNETIC RESONANCE DETECTION OF TRAPPING IN A ZnS:Gd PHOTOCONDUCTOR. See Abstr. 11729

539.2 : 538.27

11952 INDIRECT COUPLING OF NUCLEAR SPINS IN ANTI-FERROMAGNET WITH PARTICULAR REFERENCE TO MnF_2 AT VERY LOW TEMPERATURES. T.Nakamura.
Progr. theor. Phys., Vol. 20, No. 4, 542-52 (Oct., 1958).

Indirect coupling of nuclear spins through hyperfine interaction with spin waves is discussed in the case of antiferromagnets at very low temperatures. The line-width (~ 14 Oe) of the F^{19} nuclear magnetic resonance in MnF_2 at 1.4°K observed by Shulman and Jaccarino (Abstr. 656 of 1958) is shown to arise mainly from this coupling. The line-width of the Mn^{55} resonance in MnF_2 is also evaluated to be about 600 Oe.

539.2 : 538.27

11953 **NUCLEAR SPIN–LATTICE RELAXATION CAUSED BY PARAMAGNETIC IMPURITIES.** W.E.Blumberg.

hys. Rev., Vol. 119, No. 1, 79-84 (July 1, 1960).

The behaviour of the nuclear magnetization is examined for the
ransient region immediately following saturation of the nuclear spin
ystem in the case in which the nuclear relaxation is limited by spin
iffusion to paramagnetic impurities. Relaxation effects in the
bsence of diffusion and the presence of rapid diffusion are discussed.
n experiment is reported which substantiates the calculations for the
ase of diffusion-limited relaxation and, in addition, allows a deter-
nination of the correlation time of the magnetic moment of the para-
nagnetic ion and the coefficient of nuclear spin diffusion.

539.2 : 538.27 : 530.12

**UPPER LIMIT FOR THE ANISOTROPY OF INERTIAL MASS
ROM NUCLEAR RESONANCE EXPERIMENTS.** See Abstr. 10561

539.2 : 538.27

11954 **NUCLEAR MAGNETIC RESONANCE IN GALLIUM ANTIMONIDE.** D.J.Oliver.

. Phys. Chem. Solids, Vol. 11, No. 3-4, 257-62 (Oct., 1959).

The effects of both n-type and p-type impurities on the resonances
f Ga^{69}, Ga^{71} and Sb^{121} have been studied. P-type impurity concentra-
ons of approximately 10^{19} cm^{-3} reduce the resonance intensity by
60% in Ga^{69} and Ga^{71} and by 75% in Sb^{121}. This reduction is attribu-
ed to the quadrupolar interaction between the nuclei and the charged
npurity centres and implies fairly large "antishielding factors".
he values deduced are 49 for Sb^{121}, 175 for Ga^{69} and 321 for Ga^{71}.
negative frequency shift of 1.3 kc/s was observed in the Sb^{121}
esonance for a p-type impurity concentration of 6×10^{19} cm^{-3}, and
similar shift was observed in an n-type sample (impurity concen-
ration 2×10^{18} cm^{-3}). Both these displacements are ascribed to a
econd-order quadrupolar effect. No frequency shifts were observed
or the gallium resonances.

539.2 : 538.27

11955 **NUCLEAR MAGNETIC RESONANCE IN $KMnF_3$.** R.G.Shulman and K.Knox.

hys. Rev., Vol. 119, No. 1, 94-101 (July 1, 1960).

The nuclear magnetic resonance of fluorine in $KMnF_3$ was
tudied and hyperfine interactions between the fluorine nucleus and
ne magnetic electrons measured. The values are $A_s = (16.26 \pm 0.4) \times$
10^{-4} cm^{-1} and $(A_\sigma - A_\pi) = (0.17 \pm 0.1) \times 10^{-4}$ cm^{-1}. These values
orrespond to (0.52 ± 0.02)% 2s and (0.18 ± 0.1)% 2p character for
ne unpaired electron. The implications of these results in terms of
ne σ and π bonding in this compound are discussed. By a compari-
on with hyperfine interactions measured in recent paramagnetic
esonance studies of $KMgF_3$:Mn^{+2} the amount of distortion in the
nixed crystal is estimated. An antiferromagnetic transition is ob-
erved at 88.5° K.

539.2 : 538.27

11956 **AN EXPERIMENTAL STUDY OF THE NUCLEAR RELAXATION MECHANISM IN SEVERAL CRYSTALS.** E.R.Andrew and K.M.Swanson.

Proc. Phys. Soc., Vol. 75, Pt 4, 582-95 (April 1, 1960).

The effective nuclear spin–lattice relaxation mechanism was
letermined in a number of crystals by observing the relative satura-
ion behaviour of the lines of their quadrupole-split nuclear magnetic
esonance spectra. It is shown that all lines and combinations of
ines should have the same saturation behaviour if the mechanism is
nagnetic, and differing behaviour if the mechanism is quadrupolar.
The Na^{23} relaxation in pure synthetic crystals of sodium nitrate,
odium chlorate and sodium thiosulphate was found in each case to
e quadrupolar. The Li^7 and Al^{27} relaxation in natural mineral
rystals of spodumene and the Al^{27} relaxation in a mineral crystal
f euclase were found to be magnetic. The B^{11} relaxation in a pure
ynthetic crystal of borax was also found to be magnetic. Chemical
nalysis showed a sufficient concentration of paramagnetic impurity
n the mineral specimens to account for the dominance of the magne-
ic relaxation mechanism, and a sufficiently small concentration of
aramagnetic impurity in the three sodium salts to account for the
lominance of the quadrupolar mechanism. Despite the purity of the
orax crystal, the quadrupole moment of the B^{11} nuclei is too small
o enable the quadrupolar mechanism to compete with the magnetic
nechanism.

539.2 : 538.27

11957 **NMR AND IR STUDY OF $(NH_4)_2SO_4$ AND $(NH_4)_2BeF_4$.** R.Blinc and I.Levstek.

. Phys. Chem. Solids, Vol. 12, No. 3-4, 295-7 (Feb., 1960).

The n.m.r. and i.r. spectra of $(NH_4)_2SO_4$ and $(NH_4)_2BeF_4$ have been investigated both in the non-ferroelectric and in the ferroelectric phases. From the measured second moments it was found that at room temperature the reorientations of the NH_4^+ ions do not remain correlated with any specific axis of rotation. In $(NH_4)_2SO_4$, a line-width transition was found below −110° C. Below the transition, two components were resolved, which are interpreted as being due to "frozen-in" and rotating ammonium ions, respectively. Above −180° C, no line-width transition was found in $(NH_4)_2BeF_4$. This shows that the hydrogen bonds N–H ··· F are weak. In the i.r. spectra of both compounds bands involving the torsional modes of NH_4^+ ions were found. Thus the possibility of free rotation at room temperature must be excluded. The splitting of the $\nu_4(NH_4)$, $\nu_3/SO_4/$ and $\nu_3/BeF_4/$ bands below the Curie points indicates the deformation of these ions in the ferroelectric phase.

539.2 : 538.27

11958 **NUCLEAR MAGNETIC RESONANCE STUDY OF POLYCRYSTALLINE NH_4ClO_4.** J.A.Ibers.

J. chem. Phys., Vol. 32, No. 5, 1448-9 (May, 1960).

The second moments of the proton resonance absorption line in polycrystalline NH_4ClO_4 are found to be 1.27 ± 0.02 Gauss^2 at 70°K and 1.18 ± 0.01 Gauss^2 at 298°K; these results are interpreted in terms of reorientation of the ammonium ion about random or nearly random axes. Spin-lattice relaxation times for polycrystalline NH_4ClO_4 have been measured between 77° and 298°K by the progressive saturation method. These relaxation times are consistent with a barrier hindering reorientation of 2.0 ± 0.6 kcal.

539.2 : 538.27

11959 **NUCLEAR QUADRUPOLE COUPLING IN THE ALUMS.** G.Burns.

J. chem. Phys., Vol. 32, No. 5, 1585-6 (May, 1960).

The temperature dependence of the quadrupole coupling constants of Al^{27} in several ferroelectric alums was determined from the splittings of the Al^{27} nuclear magnetic resonances. The increase in the magnitudes of the coupling constants with increasing temperature is unusual. E.F.W.Seymour

539.2 : 538.27

11960 **THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL.** M.Pomerantz and T.P.Das.

Phys. Rev., Vol. 119, No. 1, 70-8 (July 1, 1960).

The theory of the origin of the field gradient at nuclei in metals is analysed, the contributions of the ion cores and conduction electrons being considered separately. For beryllium metal, using orthogonalized plane wave-functions, the conduction electrons are shown to enhance, by ~ 8%, the field gradient due to the ion cores. Combining the results of these calculations with Knight's experimental value of 48 kc/s for the Be^9 coupling constant e^2qQ/h, a value of $Q = 0.032 \times 10^{-24}$ cm^2 is obtained. The dependence of the potential for the conduction electrons on the model chosen is analysed in some detail. The various uncertainities in the field-gradient calculation and the theoretical value of the Knight shift in beryllium metal are discussed.

539.2 : 538.27

11961 **PURE QUADRUPOLE RESONANCE OF N_2 IN β QUINOL CLATHRATES.** H.Meyer and T.A.Scott.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 215-19 (Oct., 1959).

Pure quadrupole resonance of N_2^{14} molecules trapped in β quinol clathrates has been observed at temperatures below 25°K. The resonance occurs at about 3.6 Mc/s and there is an extensive fine structure of at least seven lines. The relative intensity, but not the frequency of these lines, was found to vary for samples under different conditions of annealing and concentration of trapped molecules. Studies of the Zeeman splitting of the resonance lines were made, and it was found that at these low temperatures the axes of the trapped molecules oscillate around the trigonal crystalline axis of the β quinol. The frequency of these oscillations was found to be 1.55×10^{12} sec^{-1} from preliminary measurements of the temperature-dependence of the pure quadrupole resonance. Measurement of the resonance under a hydrostatic pressure of 1790 lb./in.^{2} showed only a very small frequency increase.

MECHANICAL PROPERTIES OF SOLIDS

539.3

11962 DENSITY COUPLES AND PSEUDO-ROTATIONS IN THE THEORY OF ELASTICITY OF LAVAL. Y.Le Corre.
J. Phys., Radium, Vol. 19, No. 5, 541-7 (May, 1958). In French.

The definition of the reference system to which stress and strain are related is very important. The antisymmetric part of the strain tensor is not a rotation. The stress tensor is not necessarily symmetric. However, if the apparent strain alone is imposed, the deformation energy is extremum when the applied stress tensor is symmetric. It is shown that the Voigt theory, applied to pyroelectric crystals, leads to volume-couples. The phenomenological aspect of the theories of Voigt and Laval are also discussed.

539.3

11963 MEASUREMENT OF ELASTIC CONSTANTS OF RbBr, RbI, CsBr, AND CsI BY AN ULTRASONIC C.W. RESONANCE TECHNIQUE. D.I.Bolef and M.Menes.
J. appl. Phys., Vol. 31, No. 6, 1010-17 (June, 1960).

An ultrasonic c.w. resonance technique for the measurement of the velocity of sound in solids is described. The end correction due to the presence of the transducer and coupling film can be calculated from consideration of a transmission-line equivalent circuit. An experimental comparison is made of the c.w. and two pulse techniques over the frequency range 5-45 Mc/s. Application of the c.w. resonance technique is made to the measurement of the room-temperature adiabatic elastic constants of single crystals of RbBr, RbI, CsBr and CsI. A tabulation of the important elastic properties of these crystals is presented.

539.3

11964 APPARATUS FOR THE MEASUREMENT OF YOUNG'S MODULUS, BETWEEN –200 AND 700°C BY TRANSVERSE VIBRATION IN VACUUM. H.J.Stokes.
J. sci. Instrum., Vol. 37, No. 7, 255 (July, 1960).

Note on extension of temperature range. Apparatus described in Abstr. 8099 of 1960.

539.3

11965 ULTRASONIC INVESTIGATION OF THE ELASTIC CONSTANTS OF SOLID CARBON DIOXIDE.
V.Hovi and E.Mäntysalo.
Ann. Acad. Sci. Fennicae A VI, No. 24, 11 pp. (1959).

An ultrasonic apparatus for the measurement of the elastic constants of solids is described. Using this apparatus, the elastic constants of solid CO_2 were measured at the sublimation temperature –78.5°C and at frequencies of about 2 Mc/s. The solid carbon dioxide is considered an isotropic crystal. From the ultrasonic velocities, the adiabatic cubic compressibility of this substance was calculated. The results obtained are of the same order of magnitude as those measured previously for solid argon (Abstr. 9995 of 1955).

539.3

11966 ELASTIC CONSTANTS OF PALLADIUM FROM 4.2-300°K. J.A.Rayne.
Phys. Rev., Vol. 118, No. 6, 1545-9 (June 15, 1960).

Measurements were made on a single crystal. Extrapolation of the data to absolute zero gives (in dyne cm^{-2}): $c_{11} = 2.341 \pm 0.027 \times 10^{12}$, $c_{12} = 1.761 \pm 0.027 \times 10^{12}$, $c_{44} = 0.712 \pm 0.003 \times 10^{12}$. The corresponding value of Debye temperature is $\theta_0 = 275 \pm 8°K$, which compares well with the calorimetric figure of $\theta_0 = 274 \pm 3°K$. Both shear constants show an anomalous temperature dependence. This dependence can be correlated with the temperature variation of the contribution to $C = c_{44}$ and $C' = \frac{1}{2}(c_{11} - c_{12})$, resulting from the presence of holes in the d band of palladium.

539.3

11967 THE ELASTIC PROPERTIES OF NEUTRON IRRADIATED QUARTZ.
G.S.Zhdanov, V.G.Zubov, A.T.Ivanov and M.M.Firsova.
Kristallografiya, Vol. 3, No. 6, 720-5 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 726-30 (Jan., 1960).

The elastic constants c_{ij} of α-quartz irradiated by fast neutrons in a reactor were measured by the method of Bergman and Schaeffer. After irradiation with 2×10^{16} n/cm^2, changes were observed in the elastic constants (which exceeded the experimental error and ranged from 0.9% to 1.7%), as well as a decrease in density amounting to 0.18%. The thermal variations in the elastic constants of quartz and the variations due to irradiation corresponding to the same change in density of quartz are quite different. Qualitatively, the results agree with Mayer and Gigon's measurements (Abstr. 6641 of 1957).

539.3

11968 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF MONOCRYSTALS OF POTASSIUM BROMIDE. S.P.Nikanorov and A.V.Stepanov.
Zh. eksper. teor. Fiz., Vol. 37, No. 6(12), 1814-15 (Dec., 1959). In Russian.

This work follows an earlier study of NaCl and AgCl (Abstr. 7760 of 1956). The method is that of Hunter and Siegel (Abstr. 1360 of 1942). Results are given from room temperature to the melting point, with an accuracy of about 1%. The values extrapolated to 0°K agree with those of Galt (Abstr. 2980 of 1948). I.D.C.Gurney

539.3

11969 THERMO-ELASTIC CONSTANTS OF [15] ALKALI HALIDES OF THE NaCl-TYPE. S.Haussühl.
Z. Phys., Vol. 159, No. 2, 223-9 (1960). In German.

Measured using ultrasonic methods. The constants show only small variations within the crystal group and may therefore be regarded as typical for NaCl crystals.

539.3 : 539.2 : 538.2

TEMPERATURE DEPENDENT MAGNETIC CONTRIBUTIONS TO THE HIGH FIELD ELASTIC CONSTANTS OF NICKEL AND AN Fe–Ni ALLOY. See Abstr. 11874

539.3

11970 AN ELECTROMAGNETIC TORSION APPARATUS FOR THE MEASUREMENT OF INTERNAL ATTENUATION IN METALS. F.X.Eder and H.Haefner.
Exper. Tech. der Phys., Vol. 7, No. 6, 280-6 (1959). In German.

An apparatus is described for measuring internal friction of metallic wires in the frequency range 10^{-4} to 1 c/s. The metal wire forms the suspension of a torsion pendulum which is set into simple harmonic oscillation by means of a magnet attached to the torsion system and by static energizing coils. The method consists essentially of measuring the phase difference between the applied sinusoidal torque and the resulting torsional oscillations. The measurements can readily be made with different amplitudes of oscillation and at different temperatures; loss tangents down to 7×10^{-4} can be detected. R.Parker

539.3

11971 ANOMALIES OF INTERNAL FRICTION AND THE ELASTICITY MODULUS IN FERROMAGNETICS NEAR THE CURIE POINT. K.P.Belov, G.I.Kataev and R.Z.Levitin.
Zh. eksper. teor. Fiz., Vol. 37, No. 4(10), 938-43 (Oct., 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 4, 670-3 (April, 1960).

The temperature dependence of Young's modulus and internal friction was measured for alloys of the Elinvar and Coelinvar types and also in nickel and nickel-zinc ferrite. An internal friction peak, a jump in Young's modulus and effect of the magnetic field on the dynamic Young's modulus were detected near the Curie point in alloys possessing large paraprocess magnetostriction. It is shown that these phenomena are due to redistribution of spins within the domains induced by elastic stresses. The results are treated thermodynamically.

539.3

11972 ANOMALIES IN YOUNG'S MODULUS AND INTERNAL FRICTION OF THE Fe_3Pt ALLOY.
G.I.Kataev and Z.D.Sirota.
Zh. eksper. teor. Fiz., Vol. 38, No. 4, 1037-47 (April, 1960). In Russian.

Results are presented on the temperature dependences of Young's modulus E and internal friction of a disordered alloy with a composition close to Fe_3Pt. A very large anomaly in Young's modulus and a sharp internal friction maximum were observed in the vicinity of the ferromagnetic Curie point (71°C). Application of a magnetic field leads to appearance of two types of ΔE effects (of different sign) due to the domain structure and to a decrease of the dynamic Young's modulus near the Curie point as a result of internal domain spin ordering. The experimental variation of Young's modulus is compared with the dependence of the modulus deduced from the relaxation thermodynamic theory on the basis of magnetic data.

539.3

11973 DISLOCATION DAMPING EFFECTS IN ROCK SALT

C.L.Bauer and R.B.Gordon.

. appl. Phys., Vol. 31, No. 6, 945-9 (June, 1960).

Internal friction measurements made as a function of strain mplitude on deformed sodium chloride single crystals were followed y elastic modulus measurements made during X-irradiation of the ame crystals. Etch pit densities were also determined. These ata were used to evaluate the constants in a theory, proposed by ranato and Lücke (Abstr. 5455, 6970 of 1956) which permits the alculation of the average length of the dislocation segments, L, hich vibrate under an applied alternating stress. An independent etermination of the magnitude of L was made from the elastic odulus data using a method developed by Gordon and Nowick (1956). is concluded that the theories tested give a useful representation f dislocation damping phenomena in sodium chloride and permit use f internal friction measurements for the continuous observation of islocations.

539.3 : 534.22

11974 ISENTROPIC COMPRESSIBILITY OF ALUMINIUM, COPPER, LEAD AND IRON AT HIGH PRESSURES.

.V.Al'tshuler, S.B.Kormer, M.I.Brazhnik, L.A.Vladimirov, I.P.Speranskaya and A.I.Funtikov.

h. eksper. teor. Fiz.,Vol. 38, No. 4, 1061-73 (April, 1960). In ussian.

A method is described for measuring the velocity of propagation f weak perturbations behind the front of powerful shock waves. Two ound velocities corresponding to elastic and plastic states of matter ere detected. Velocities of sound and the isentropic compression noduli were measured for aluminium, copper, iron and lead in the ressure range 0.4-3.5 × 10^6 atm. Thermal energies, temperatures f shock compression and Grüneisen coefficients were estimated rom the experimental results.

539.3

11975 POWER LAW FOR CREEP.

B.J.Rigby.

rit. J. appl. Phys., Vol. 11, No. 7, 281-3 (July, 1960).

A model is discussed which gives rise to the widely used power aw for creep under constant load, namely, $dl/dt = \Omega t^{-n}$, where l is he strain, t the time, Ω a function dependent on temperature and oad and n an exponent which may have any value between 0 and 1. n this model,the exponent n is interpreted as a function of the umber of "flow units" which must be activated simultaneously efore flow can take place.

539.3

11976 SURFACE DEFORMATION OF ALUMINUM IN FATIGUE.

J.C.Grosskreutz and C.M.Gosselin.

. appl. Phys., Vol. 31, No. 6, 1127-8 (June, 1960).

Fatigued specimens were sectioned in a Porter—Blum microome using a diamond knife and then examined by microscopy. This a convenient and quick method for examining the deeper "persisent" slip bands from which, as experiment shows, fatigue cracks riginate. A.E.Kay

539.3

11977 I. THE ELASTIC BEHAVIOUR OF METALS IN TENSILE TEST WITHIN THE PLASTIC DEFORMATION RANGE.

.Frinken and E.Kappler.

'orschber. Landes Nordrhein-Westfalen, No. 687, 3-31 (1959). n German.

The specimens of duralumin, brass and 99.9% pure Fe and Ni, n the form of tension bars, were subjected to different heat treatnents up to 700°C and their elastic behaviour examined using a -ton tensile testing machine. The results, shown graphically, show hat $F = C\sigma^4$ for a given strain, and $F = A + B\sigma$ where σ is the maxinum stress of the loop and A, B and C are dependent on the material nd its heat treatment. A is negative and of magnitude such that ' decreases with the tempering temperature. X-ray photographs how that the variation in breadth of the Debye-Scherrer lines is in ccord with the hysteresis results. S.Weintroub

539.3

11978 II. INVESTIGATIONS OF THE ELASTIC BEHAVIOUR OF METALLIC SUBSTANCES WITHIN THE PLASTIC EFORMATION RANGE BY THE BRINELL BALL PRESSURE TEST.

.Vanheiden and E.Kappler.

'orschber. Landes Nordrhein-Westfalen, No. 687, 33-55 (1959). German.

The apparatus used, consisting essentially of an hydraulic oil press and an optical interferometer, is fully described and illustrated. The materials tested were dixistahl and electrolytic copper. The experimental results show that Hertz's formula is applicable only for very small (practically inaccessible) proof loads. A more generalized formula is derived which by suitable choice of parameters is in agreement with the experimental results. S.Weintroub

539.3

11979 INVESTIGATION OF THE INITIAL STAGES OF PLASTIC DEFORMATION OF ROCK SALT CRYSTALS.

R.I.Garber and L.M.Polyakov.

Zh. eksper. teor. Fiz., Vol. 36, No. 6, 1625-30 (June, 1959). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 6, 1158-62 (Dec., 1959).

Plastic deformation processes in rock salt, involving the formation of elementary displacements that constitute a special deformation stage, are investigated. Further deformation results in single slip bands. The activation energy required for the annealing of the residual stresses of the elementary displacements is half that of the slipping bands. An additional attenuation of light has been detected near the traces of the elementary displacements. It is proposed to attribute this to the influence of systems of line inhomogeneities differently oriented on both sides of each trace. It is established that certain traces of elementary displacements contract after removal of the load, similar to the case of elastic twins of sodium saltpeter. It is established that the trace of the elementary displacement on the lateral surface of the crystal has a smooth profile, extending over a distance of approximately 1500 A. The smooth form of the profile is well explained by the influence of surface-tension forces, which are in thermodynamic equilibrium with the additional residual stresses.

539.4

11980 STRENGTH OF IRRADIATED DRAWN AND UNDRAWN NYLON.

C.C.Hsiao, Y.C.Das and A.Haynes.

Brit. J. appl. Phys., Vol. 11, No. 7, 277-9 (July, 1960).

This investigation describes the effect of reactor irradiation on the strength properties of oriented and unoriented nylon filaments. It is found that both the ultimate strength and the elastic modulus of the undrawn sample decreases markedly to a minimum upon receiving a reactor radiation indexed by the thermal neutron component of 6 × 10^{17} nvt as compared with that of the drawn sample. However, at somewhat higher levels of irradiation the ultimate tensile strength and the modulus of elasticity of the undrawn nylon increases while that of the drawn nylon continues to decrease until they approach to nearly the same level. At still a higher dose of reactor irradiation the ultimate tensile strength of both drawn and undrawn samples drops sharply while the modulus of elasticity increases sharply.

539.4

11981 TENSILE STRENGTH OF PYROLYTIC GRAPHITE UP TO 2750°C.

H.E.Martens and L.D.Jaffe.

J. appl. Phys., Vol. 31, No. 6, 1122 (June, 1960).

The strength of pyrolytic graphite (sp. gravity 2.20) is about an order of magnitude greater than the strength of commercial synthetic graphites (sp. gravity 1.5 to 1.8) and it appears to increase with temperature up to 2750°C. J.Adam

539.4

11982 THE QUESTION OF THE CONDITIONS OF REVERSIBILITY OF THE RUPTURE PROCESS IN METALS UNDER LOAD.

B.Ya.Pines and A.F.Sirenko.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1312-15 (April 21, 1960). In Russian.

The life under a fixed load of sintered copper specimens was determined, and the mean life τ obtained from the frequency distribution curve. Similar experiments were carried out on sets of specimens loaded for 15 min, then annealed at various temperatures, and finally tested for longevity (mean life τ_A). Testing was carried out at room temperature and at 600°C. The difference $\tau_A - \tau$ is proportional to $\sqrt{t}$, where t is the duration of annealing, and it is concluded that the growth of cracks and their healing are both probably diffusion processes. R.F.S.Hearmon

539.4

11983 TIME DEPENDENT TENSILE STRENGTH OF SOLIDS.

C.C.Hsiao.

Nature (London), Vol. 186, 535-7 (May 14, 1960).

A linear relation between the stress and the logarithm of the strain-rate is noted and shown to hold for a large number of solids. The analogous relation between breaking stress and the logarithm of the time to break has been reported previously by the author (Abstr. 13864 of 1959) and elsewhere. Agreement with current theories is found, and the linear relation between log (strain rate) and applied tensile stress is suggested as a basic law in describing the time-dependent tensile strength properties of many solids.

R.G.C.Arridge

539.4

11984 THE TEARING OF NOTCHED ALUMINIUM FOILS.
J.Remmelts and R.Moch.

Appl. sci. Res. A, Vol. 9, No. 1, 1-8 (1959).

Tension tests on notched aluminium foils are described. The foils were provided either with one internal notch or with two notches on the foil edge. The tearing force was determined as a function of either the notch depth or the relative position of the notches. The longitudinal tension causes a transversal bulging of the foil. No quantitative explanation of the results is given.

539.4

11985 A SIMPLE MODEL OF A PROPAGATING CRACK.
A.N.Stroh.

J. Mech. Phys. Solids, Vol. 8, No. 2, 119-22 (May, 1960).

A model of a crack is developed in which the surface energy in the Griffith treatments is taken to depend on the temperature and strain rate. It is shown that such a crack shows a transition from brittle to ductile behaviour as the temperature is raised.

539.4

11986 CONE CRACKS IN FUSED SILICA.
J.J.Benbow.

Proc. Phys. Soc., Vol. 75, Pt 5, 697-9 (May, 1960).

Cone fractures were produced in fused silica, by indenters ranging from $\frac{1}{64}$ inch to $\frac{1}{4}$ inch diameter. In some respects these differ from cone cracks in silicate glass. Those in silica have a significantly smaller semiangle, 65.5° as opposed to 68.5° in glass. Whereas cracks in glass grow indefinitely under a constant load, and remain visibly open when the load is removed, those in quartz cease to grow about ten minutes after each increment of the load, and cannot be seen when the specimen is unloaded.

539.4

11987 THERMAL HARDENING OF THE TWIN INTERLAYERS IN IRON. R.I.Garber, I.A.Gindin and Ya.D.Starodubov.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1801-5 (Dec., 1959). In Russian.

By using stepwise deformations at 4.2°K, with intermediate heating up to room temperature, a considerable increase of the yield point (thermal hardening) of the coarse-grained iron of high purity (99.99%) was achieved, most of the hardening taking place after the first heating. The hardening is localized at the boundaries between the twin interlayers and the parent crystal, and by the polygonization of zone adjacent to the twin boundary, which moves during deformation.

F.Lachman

539.4

11988 RADIATION-INDUCED HARDNESS CHANGES IN GRAPHITE. K.E.Horton and R.L.Carter.

Nuclear Sci. Engng, Vol. 2, No. 4, 513-15 (July, 1957).

Changes in Knoop Hardness of artificial graphite from the range 9 to 12 to the range 30 to 75 are found to accompany fast neutron irradiation at 30°C.

539.8

11989 ELECTROSTATIC ACCELERATION OF MICRO-PARTICLES TO HYPERVELOCITIES.

H.Shelton, C.D.Hendricks, Jr and R.F.Wuerker.

J. appl. Phys., Vol. 31, No. 7, 1243-6 (July, 1960).

By electrostatic methods, spheres of iron with radii in the micron range were accelerated to hypervelocities. Techniques were developed to give single impacts in vacuum of measured incident velocity, mass, and position.

539.8

11990 IMPACT CRATER FORMATION IN ROCK.
W.C.Maurer and J.S.Rinehart.

J. appl. Phys., Vol. 31, No. 7, 1247-52 (July, 1960).

Craters were produced by firing spherical steel projectiles of $\frac{3}{16}$ and $\frac{9}{32}$ in. diameter into sandstone and granite at velocities ranging from 300 to 6000 ft/sec. Impact angles of 30, 60, and 90 deg were used for the sandstone and 90 deg for the granite. The craters are formed by two mechanisms: (a) crushing of material in front of the projectile and (b) fracturing which takes place as fractures are initiated by a constant impulse in steplike fashion in from of the projectile and propagated along logarithmic spirals of maximum shear to the free surface of the rock. The volume of the material removed by crushing varies as the first power of the impact velocity and the volume removed by fracturing, as the second power of the impact velocity. Penetration varies linearly with the impact velocity and is inversely proportional to the specific acoustic resistance of the target material, the proportionality constant being dependent upon the shape of the projectile.

539.8

11991 CONCERNING THE IMPACT OF SOLIDS AT HIGH VELOCITIES. K.P.Stanyukovich.

Zh. eksper. teor. Fiz., Vol. 36, No. 5, 1605-6 (May, 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 36(9), No. 5, 1141 (Nov., 1959).

When a solid body strikes a solid barrier at very high impact velocity an explosion-like effect occurs. An analogy with TNT explosion effects is drawn and it is shown that the momentum acquired by the medium during impact and from the explosion depends on the explosion momentum and is practically independent of the angle of impact for all except very large angles of impact, i.e. when normal impact velocity becomes small. The speeds considered are of the order of 10 km/sec and upwards.

T.C.Toye

CRYSTALLOGRAPHY

CRYSTAL STRUCTURES

539.2 : 548

11992 PREFERENTIAL ORIENTATIONS FORMED ON THERMAL DECOMPOSITION OF SINGLE CRYSTALS OF K_2PtCl_6, K_2PtCl_4 AND $(NH_4)_2PtCl_6$.

W.G.Burgers, W.J.M.Rootsaert, A.J.Bogers and C.F.Cornet.
Proc. K. Ned. Akad. Wetensch. B, Vol. 63, No. 2, 113-26 (1960).

On reduction in a hydrogen atmosphere at about 100-200°C both potassium salts produce KCl with a pronounced texture related to the original lattice orientation of the mother crystal and a much weaker Pt texture parallel to the KCl. The ammonia salt gives platinum with a random orientation. The orientations were determined with X-rays. Electron diffraction experiments established that neither KCl evaporated onto K_2PtCl_6 nor Pt evaporated onto KCl show preferred orientation.

J.E.Caffyn

539.2 : 548

11993 ALIGNED CRYSTALS IN METALS.
B.D.Cullity.

Sci. American, Vol. 200, No. 4, 125-6, 128, 130, 132, 134, 137-8, 141 (April, 1959).

General description of the effect of grain orientation on the properties of metals in bulk, with particular reference to the mechanical and magnetic properties of iron.

539.2 : 548

11994 THE DEPENDENCE OF THE CONDENSATION COEFFICIENT OVER A CRYSTAL SURFACE ON THE PARTIAL PRESSURE. R.Jaeckel and W.Peperle.

Z. Naturforsch., Vol. 15a, No. 2, 171-2 (Feb., 1960). In German.

A torsion apparatus was used to measure the vapour pressure over single-crystal surfaces as a function of the partial pressure. The increased vapour pressure at low partial pressures is discussed in relation to the micromorphology of the crystal surfaces.

J.E.Caffyn

539.2 : 548

11995 DOES THE NON-CONSERVATION OF PARITY GIVE RISE TO THE PREFERENTIAL FORMATION OF CRYSTAL ENANTIOMORPHS? O.Kratky.

Z. Naturforsch., Vol. 15a, No. 2, 172 (Feb., 1960). In German.

539.2 : 548.3

11996 CHARACTERISTICS OF THE $\{111\}$ SURFACES OF THE III—V INTERMETALLIC COMPOUNDS.

H.C.Gatos and M.C.Lavine.

. Electrochem. Soc., Vol. 107, No. 5, 427-33 (May, 1960).

Surface characteristics of the $\{111\}$ crystallographic planes of he III—V intermetallic compounds (zinc-blende structure), and in articular those of InSb, are discussed. The polarity of these comounds along the $\langle 111\rangle$ directions leads to pronounced physical hemical differences between the $\{111\}$ surfaces terminating with roup III atoms and those terminating with group V atoms. Differnces in etching, dislocation etch pit formation, and electrode potenial are presented. Dislocation etch pits form on the group III suraces and not on the group V surfaces of the six compounds investiated (InSb, GaSb, AlSb, InAs, GaAs, and InP). A proposed interretation is based on the relative reactivity of the group III and group ' atoms as affected by their bond configuration and the polarity of he zinc-blende structure.

539.2 : 548.5

11997 ELECTRON MICROSCOPICAL INVESTIGATION OF CLEAVAGE FACES OF InSb SINGLE CRYSTALS.

.Feltynowski and L.Górski.

cta phys. Polon., Vol. 18, No. 6, 279-93 (1959). In German.

Single crystals of indium antimonide were cleaved along the 111) and (100) faces, and zaponlack—aluminium replicas were made rom the exposed surfaces. The main structural elements are the leavage steps and the slip lines. The cleavage steps originate rom screw dislocations, the displacement vector of which is perpenicular to the cleavage face, or in the general case intercepts this ace. At grain boundaries small cleavage steps are mainly formed. hich later unite to form bigger steps and so-called "river patterns". he cleavage steps run in the direction of cleaving. On the (100) leavage face two sets of slip systems at a mutual angle of 45° are bserved, which arise from two different slip planes, (111) and (110).

V.E.Cosslett

539.2 : 548.5

11998 STUDY OF THE CRYSTALLINE TRANSFORMATIONS IN ZnS:Cu, ZnS:Ag AND ZnS:Cu, Al.

.Aven and J.A.Parodi.

. Phys. Chem. Solids, Vol. 13, No. 1-2, 56-64 (May, 1960).

An e.p.r. study has shown that the formation of a separate phase f copper (or silver) sulphide in polycrystalline ZnS:Cu, ZnS:Ag and nS:Cu, Al triggers the rapid transformation of hexagonal to cubic inc sulphide. It is believed that, after firing, cuprous sulphide preipitates from solution in hexagonal zinc sulphide and in so doing upplies the energy necessary for nucleation of cubic zinc sulphide. nce nucleation has begun, growth of the cubic phase will be selfustaining, because energy is released in going from the hexagonal the cubic structure. Supporting data for the postulated mechanism f nucleation and growth is provided by X-ray diffraction data on the ffect of quenching and annealing on the crystal structure of nS:9×10^{-4} Cu phosphors. It was found that the optimum nucleation emperature lies close to 700°C and that at this temperature the rowth of the cubic phase is reasonably fast.

539.2 : 548.5

11999 DISTORTION OF THE CRYSTAL LATTICE ON THE GRAIN BOUNDARY OF A MECHANICALLY TWINNED ALCITE CRYSTAL. G.B.Rais.

ristallografiya, Vol. 3, No. 3, 325-8 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 3, 328-31 (May-June, 1958).

Investigated by measuring the solubility of the face parallel to he slip plane. The dimensions of the distorted region have been scertained.

539.2 : 548.5

12000 X-RAY DIFFRACTION STUDY OF THE ACCOMMODATION ZONE IN TWINNED ZINC.

.I.Startsev and F.F.Lavrent'ev.

ristallografiya, Vol. 3, No. 3, 329-33 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, o. 3, 332-6 (May-June, 1958).

An account is given of the results of an investigation of the acommodation zone forming in a deformed single crystal of zinc and f the effect of heat-treatment on this zone. It is shown that there xists a boundary layer with a distorted crystal lattice.

539.2 : 548.5

12001 A POSSIBLE MECHANISM OF TWINNING IN CsI AND CsBr CRYSTALS. E.V.Kolontsova and I.V.Telegina.

ristallografiya, Vol. 3, No. 3, 334-8 (1958). In Russian. English ranslation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 337-40 (May-June, 1958).

The displacements of atoms required for a reorientation of the crystal in twinning deformation are reviewed. It is established that for the majority of twin planes the least displacements correspond to ring displacements of groups of atoms similar to those which occur in ring diffusion.

539.2 : 548.5

12002 DISLOCATIONS AND TWINNING IN GRAPHITE. A.J.Kennedy.

Proc. Phys. Soc., Vol. 75, Pt 4, 607-11 (April 1, 1960).

The twin composition plane in graphite is a 20° tilt boundary between lattices which are rotated, relatively, about an axis in the basal plane. Previous work has led to the proposition that some special type of structure must necessarily exist in the neighbourhood of the boundary which violates the normal hexagon arrangement of the carbon atoms. It is demonstrated that a tilt boundary of the required form can be explained as an array of partial dislocations, such a boundary being possible in either the hexagonal or the rhombohedral form. A boundary of this type is mobile, and can, by its movement, introduce or eliminate stacking faults and thus change the volume of rhombohedral graphite present in the normal hexagonal lattice. Such effects have been reported previously. The true twinning plane in this model is not the composition plane, which is the plane $\{1\bar{1}01\}$ referred to the structural (not the morphological) axes, but the plane $\{11\bar{2}1\}$.

539.2 : 548.5

12003 ON THE CONDENSATION COEFFICIENT IN THE GROWTH OF SILVER FROM THE VAPOR PHASE.

R.A.Rapp, J.P.Hirth and G.M.Pound.

Canad. J. Phys., Vol. 38, No. 5, 709-12 (May, 1960).

Condensation coefficients for silver were determined at relatively high fluxes of $1.3 - 4.5 \times 10^{14}$ atoms $\mathrm{cm}^{-2}\,\mathrm{sec}^{-1}$ and temperatures between 45° and 440°C. The coefficients were 1.00 with a maximum error of ± 0.02. The adsorption of residual gases at 199° and 205°C did not decrease the value of the condensation coefficient from unity.

R.Schnurmann

539.2 : 548.5 : 538.2

NUCLEATION EXPERIMENTS ON THIN MAGNETIC MnBi FILMS. See Abstr. 11862

539.2 : 548.5

12004 THE GROWTH OF CRYSTALS IN SYSTEMS CONTAINING IMPURITIES. V.Ya.Khaimov-Mal'kov.

Kristallografiya, Vol. 4, No. 1, 114-18 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 105-8 (Jan., 1960).

It is demonstrated from theory and experiment that the effects of an impurity on the crystallization are equivalent to the effects of a single-phase (crystallization) pressure, equal in magnitude to the osmotic pressure produced by the impurity.

539.2 : 548.5

12005 A METHOD OF GROWING HOMOGENEOUS SINGLE CRYSTALS OF ALLOYED SEMICONDUCTING MATERIALS, SOLID SOLUTIONS AND INTERMETALLIC COMPOUNDS OF DEFINITE COMPOSITION, GIVEN THE COMPOSITION OF THE MELT. S.V.Airapetyants and G.I.Shmelev.

Fiz. tverdogo Tela, Vol. 2, No. 4, 747-55 (April, 1960). In Russian.

Existing methods of producing crystals are reviewed and discussed in relation to the constitution diagram. A new method based on the floating crucible modification of the Czochralski technique is proposed and analysed mathematically. Some experimental details are given. See also Abstr. 4100 of 1959.

R.F.S.Hearmon

539.2 : 548.5

12006 IMPROVEMENTS ON THE PEDESTAL METHOD OF GROWING SILICON AND GERMANIUM CRYSTALS.

W.C.Dash.

J. appl. Phys., Vol. 31, No. 4, 736-7 (April, 1960).

Describes some modifications to the method (Abstr. 8517 of 1958; 7598 of 1959) which permit the growth of large crystals of similar perfection (i.e., dislocation free). The crystals are pulled from a molten mound on a tapered pedestal of the same material. Dimensions are given.

W.Bardsley

539.2 : 548.5

12007 PROMOTION OF CUBIC GROWTH IN 3% SILICON IRON BY CONTROL OF ANNEALING ATMOSPHERE COMPOSITION. D.Kohler.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 408S-409S (May, 1960).

Under certain special conditions of processing and annealing, silicon iron can be made to have cubic orientation. This phenomenon was first reported by Assmus et al. The driving force for the growth of the cubic grains has been determined to be surface energy. The author has found that by controlling the concentration of impurities in the annealing atmosphere the growth of grains having the (100) plane parallel to the sheet surface can be greatly improved. Calculations of the surface energies in the body-centred system show that the surface energy of atomic planes are (110), (100) and (111) in order of ascending values. From this orientation dependency of the surface energy, there results a discrepancy between theory and the observed fact of (100) surface energy growth. It is proposed that adsorption by the metal surface of atmosphere constituents in a very special manner can accomplish a change in relative surface energy so that the (100) plane becomes the lowest energy crystal plane. Data on some atmosphere composition effects on transformation to cube texture of silicon iron 2 to 14 mils thick were obtained. The degree of transformation was found to be closely related to the concentration of certain compounds that are added to the atomsphere. The degree of cube growth reaches a maximum at a certain small concentration of impurity. These effects were studied in both metal and ceramic annealing tubes. With proper additives excellent cube growth can be obtained in either type annealing tube.

539.2 : 548.5

12008 GROWTH OF SINGLE CRYSTALS OF ANTHRACENE. J.N.Sherwood and S.J.Thomson.

J. sci. Instrum., Vol. 37, No. 7, 242-5 (July, 1960).

Single crystals of anthracene were grown from melts of zone-purified material, in an all-glass oven. The important factors which governed the successful growth of single crystals by the moving-vessel technique were investigated, viz. the purity of the anthracene, the temperature gradient, the shape of the growth vessel and the growth rate.

539.2 : 548.5

12009 PROPAGATION MECHANISM OF GERMANIUM DENDRITES. D.R.Hamilton and R.G.Seidensticker.

J. appl. Phys., Vol. 31, No. 7, 1165-8 (July, 1960).

The role of the twin planes in the rapid dendritic propagation of germanium crystals is examined on the basis of corner nucleation. A model is proposed, and it is shown that at least two twin planes must be present for continued easy propagation in 211 directions, in good agreement with experimental observations. The absence of the dendrite with only one twin is explained.

539.2 : 548.5

12010 GROWTH OF ATOMICALLY FLAT SURFACES ON GERMANIUM DENDRITES.

R.L.Longini, A.I.Bennett and W.J.Smith.

J. appl. Phys., Vol. 31, No. 7, 1204-7 (July, 1960).

This note presents a theory of the formation of extended flat surfaces on germanium dendrites. It is suggested that part of the liquid—solid interface is a supercooled {111} surface, on which new atomic planes are occasionally nucleated. Thermal limitations on the nucleation and propagation of these monolayers are discussed. When such a growing layer reaches the melt surface it creates a step on the solid. It is proposed that the meniscus momentarily sticks to the corner of this step. Subsequent planes nucleated during this sticking period result in a step several atomic layers high, in accord with experiment. Elementary estimates of corner energy and amount of meniscus sticking yield results consistent with experiment.

539.2 : 548.5

12011 ETCH PITS ON DENDRITIC GERMANIUM. A CLARIFICATION. P.J.Holmes.

Phys. Rev., Vol. 119, No. 1, 131-2 (July 1, 1960).

Previous reports by Billig and Holmes (Abstr. 7496 of 1955) of the orientations of etch pits on the main faces of germanium dendrites are not at first sight consistent with those recently reported by Bennett and Longini (Abstr. 1891 of 1960). It is shown that this discrepancy arose because the orientation of equilateral pits on 111 surfaces depends on the etchant used. A check on the earlier work confirms that there is in fact no contradiction; ferricyanide and WAg etches produce pits which point upwards on "perfect" faces grown in a "G direction", while superoxol and similar etchants give pits pointing downwards.

539.2 : 548.5

12012 OBSERVATIONS ON THE EPITAXY OF YELLOW MERCURIC IODIDE AND MERCURIC BROMIDE ON MICA. J.Jaffray and M.T.Majourel.

J. Phys. Radium, Vol. 19, No. 1, 109-10 (Jan., 1958). In French.

Yellow HgI_2 and $HgBr_2$, sublimed on a (001) face of mica, grew in three orientations corresponding to [010] directions in the mica. Phase transformations from yellow to red HgI_2 were induced at room temperature, sharp phase boundaries were often obtained, probably at cracks in the crystal. J.Franks

539.2 : 548.5

12013 ETCH PITS AT DISLOCATIONS IN COPPER. J.D.Livingston.

J. appl. Phys., Vol. 31, No. 6, 1071-6 (June, 1960).

A modification of an etch discovered by Lovell and Wernick (Abstr. 2509 of 1959) has been shown to be a reliable means of revealing dislocations as etch pits on (111) faces of copper crystals. The etch has been employed to study dislocation distributions in as-grown, annealed, and deformed crystals. A high-temperature anneal is found to lower the dislocation density of melt-grown crystals. A "double-etch" technique is employed to observe the motion of dislocations, and to show that the dislocations initially present in these crystals are mobile at low stresses. Sub-boundaries are numerous in these crystals and are found capable of hindering dislocation movement. Observations of the dislocation structure of crystals deformed in bending and in tension are reported, including the appearance of "glide polygonization" after room-temperature deformation.

539.2 : 548.7

12014 INFLUENCE OF PROTECTIVE PAPER ON X-RAY DIFFRACTION PHOTOGRAPHS.

H.Ruck, M.Kouris and R.St.J.Manley.

J. sci. Instrum., Vol. 37, No. 6, 223-4 (June, 1960).

Possible errors which may arise due to the use of paper to protect the film against exposure from light are considered.

C.J.Batty

539.2 : 548.7

12015 LIQUID-NITROGEN CRYOSTAT FOR SINGLE-CRYSTAL X-RAY DIFFRACTION. A.E.Attard and L.V.Azároff.

J. sci. Instrum., Vol. 37, No. 7, 238-9 (July, 1960).

The cryostat employs a continuous flow of precooled gas to maintain a small single crystal mounted on a fibre at $-190^\circ \pm 2^\circ$C. The cooling chamber is completely enclosed so that a relatively small amount of coolant is required. Higher temperatures can be maintained to within two degrees by simply decreasing the gas flow rate.

539.2 : 548.7

12016 A CRYOSTAT FOR NEUTRON DIFFRACTION INVESTIGATIONS. R.A.Alikhanov.

Zh. eksper. teor. Fiz., Vol. 38, No. 3, 806-8 (March, 1960). In Russian.

A low-temperature (including helium temperatures) cryostat is described which can be employed to study scattering of thermal neutrons on polycrystalline samples.

539.2 : 548.7

12017 THE USE OF A SCINTILLATION COUNTER IN X-RAY STRUCTURE ANALYSIS.

D.M.Kheiker, I.E.Konstantinov and V.A.Alekseev.

Kristallografiya, Vol. 4, No. 1, 54-61 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 48-53 (Jan., 1960).

An arrangement is described for recording an X-ray diffraction pattern by means of a scintillation counter with a differential discrimination attachment. The apparatus is intended for use with the diffractometer URS-50 I.

539.2 : 548.7

12018 METHOD OF RECORDING LOW-ANGLE X-RAY SCATTERING WHEN INTENSITY SCATTERED BY SPECIMEN CHANGES RAPIDLY WITH TIME. P.W.Teare.

Brit. J. appl. Phys., Vol. 11, No. 7, 287-9 (July, 1960).

The use of the method is illustrated by an example taken from n age hardening aluminium–zinc alloy. Two methods of recording he intensity data are discussed and it is thought that an improvement in the facility of recording could be obtained by the use of roportional counting.

539.2 : 548.7 : 537.533

A DOUBLE OBJECT CHAMBER FOR THE STUDY OF DOUBLE DIFFRACTION OF ELECTRONS BY TWO CRYSTAL LATTICES.

See Abstr. 10966

539.2 : 548.7

12019 THE EXTINCTION RULE FOR REFLEXIONS IN SYMMETRICAL SPOT PATTERNS OF ELECTRON IFFRACTION BY CRYSTALS.

S.Miyake, S.Takagi and F.Fujimato.
cta cryst., Vol. 13, Pt 4, 360-1 (April, 1960).

539.2 : 548.7

12020 INTENSITY OF THE (111) REFLEXION FOR DIAMOND.

R.Brill and H.Barth.
ature (London), Vol. 184, 264 (July 25, 1959).

An interpretation is given of recently observed deviations from he expected value for the intensity of the X-ray reflection in dianond from (111). It is considered that the accumulation of binding lectrons between two carbon atoms in diamond gives rise to the ppearance of (222), strengthens the intensity of (111) and does not ffect (220), which is in fact all in agreement with observation.

S.Tolansky

539.2 : 548.7

12021 DYNAMICAL X-RAY DIFFRACTION THEORY OF SPHERICAL WAVES.

N.Kato.
. Naturforsch., Vol. 15a, No. 4, 369-70 (April, 1960).

Formulae are obtained by expressing a spherical wave as a uperposition of plane waves. The theory can explain the Pendellöung fringes (see Abstr. 13902 of 1959).

A.R.Stokes

539.2 : 548.7

12022 THEORY OF X-RAY SCATTERING BY DISTORTED CRYSTALS. I. THEORY WITHOUT ATOMIC FACTORS.

.N.Filipovich.
h. tekh. Fiz., Vol. 28, No. 12, 2716-26 (Dec., 1958). In Russian.
nglish translation in: Soviet Physics—Technical Physics (New York), ol. 3, No. 12, 2486-95 (Dec., 1958).

An account is given of the general theory of scattering by rystals which contain internal cavities, cracks and deformations; he theory is based on direct expansion of the electron density into ourier series, without the introduction of atomic factors.

R.Bullough

539.2 : 548.7

12023 THEORY OF X-RAY SCATTERING BY DISTORTED CRYSTALS. II. THEORY WITH ATOMIC FACTORS.

.N.Filipovich.
h. tekh. Fiz., Vol. 28, No. 12, 2727-38 (Dec., 1958). In Russian.
nglish translation in: Soviet Physics—Technical Physics (New ork), Vol. 3, No. 12, 2496-506 (Dec., 1958).

The treatment of the previous abstract is redeveloped with the tomic factors included, and use is again made of standard Fourier nalysis. This latter treatment, though more complex than the ormer, appears to be more accurate in describing the effects of isplacements of atoms from their ideal sites. Detailed comparison ith other relevant theories is made.

R.Bullough

539.2 : 548.7 : 519

12024 METHOD TO OBTAIN THE CHARACTER TABLES OF NONSYMMORPHIC SPACE GROUPS.

J.Zak.
. math. Phys. (New York), Vol. 1, No. 3, 165-71 (May-June, 1960).

A method is developed to obtain the character tables of nonymmorphic space groups. The method is based on the possibility f obtaining all the irreducible representations of a group, if one nows all the irreducible representations of its invariant subgroup of dex 2 or 3. It turns out that all the space groups have an invarint subgroup of index 2 or 3.

539.2 : 548.7

12025 DETERMINATION OF THE ATOMIC SCATTERING AMPLITUDES IN CRYSTALS ON THE BASIS OF XPERIMENTALLY DETERMINED STRUCTURE AMPLITUDES.

.Kurki-Suonio.
Ann. Acad. Sci. Fennicae A IV, No. 31, 32 pp. (1959). In German

A discussion of the relationship between the structure amplitude of a limited region and those of a larger region, such as a complete crystal, of which it forms part. The unit cell is considered as a limiting case of the small region. The parallelopiped and ellipsoid are considered in detail and some preliminary results presented in connection with work on the $NaNO_3$ crystal.

J.W.Leech

539.2 : 548.7

12026 COMMENTS ON "DETERMINATION OF ATOMIC SCATTERING FACTORS".

D.R.Chipman and A.Paskin.
J. appl. Phys., Vol. 31, No. 6, 1130-1 (June, 1960).

Arguments are presented to the effect that X-ray measurements of the atomic scattering factor of Al as obtained from absolute measurements on powders by R.B.Roof, Jr (Abstr. 13358 of 1959) are in error.

J.Adam

539.2 : 548.7

12027 REPLY TO COMMENTS ON "DETERMINATION OF ATOMIC SCATTERING FACTORS".

R.B.Roof, Jr.
J. appl. Phys., Vol. 31, No. 6, 1131 (June, 1960).

In reply to Chipman and Paskin (see preceding abstract), the author agrees that the techniques described in his original paper do not lead to an absolute determination of absolute scattering factors. The observed scattering factor however is related to a theoretically correct scattering factor by $f_{theoret} = kf_{obs}$, where k is defined as an instrument calibration function.

J.Adam

539.2 : 548.7

12028 X-RAY AND NEUTRON SCATTERING FROM ELECTRONS IN A CRYSTALLINE FIELD AND THE DETERMINATION OF OUTER ELECTRON CONFIGURATIONS IN IRON AND NICKEL.

R.J.Weiss and A.J.Freeman.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 147-61 (July, 1959).

The effect of nonspherical charge distributions on X-ray and neutron scattering factors has been calculated for d- and f-electrons in cubic, tetrahedral, and hexagonal crystalline fields. The theory indicates that large deviations from the usual spherically symmetric approximation are to be expected, especially from electrons in a hexagonal environment, and that these deviations lead to a new technique for determining the spatial symmetry of the outer electrons in crystalline fields. Using this technique the measured X-ray and neutron scattering factors have been analysed to determine the outer electron distribution in iron and nickel and compared with the calculated effects of asphericity. The polarized neutron data of Nathans, Shull, et al. indicates that in b.c.c. iron the doubly and triply degenerate orbitals are equally populated, while in nickel the holes are 75% in the triply degenerate orbitals and 25% in doubly degenerate orbitals. Combining these results with the X-ray data, further analysis shows that in b.c.c. iron the spin density arises from 2.2 3d atom-like electrons in one spin direction, whereas in nickel the spin density arises from 5.0 3d atom-like electrons with spin up and 4.4 3d atom-like electrons with spin down. In nickel it is shown that the spin-up electrons have a radial charge density slightly more compressed than that of the spin-down electrons.

539.2 : 548.7

12029 A NEW TYPE OF RELATIONSHIP BETWEEN STRUCTURE FACTORS.

B.K.Vainshtein.
Kristallografiya, Vol. 4, No. 1, 3-12 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 1-9 (Jan., 1960).

Exact equalities are deduced, which, under certain conditions, relate to each other the structure factors belonging to parallel reciprocal lattice nets. These equalities are true in the general case for noncentrosymmetry, and for all atomic structures. In general, the equalities transform to inequalities and a quantitative assessment of these is given.

539.2 : 548.7

12030 ARBITRARILY ASSIGNED SIGNS IN THE DIRECT METHODS OF DETERMINING CRYSTAL STRUCTURES.

S.V.Borisov, V.P.Golovachev and N.V.Belov.
Kristallografiya, Vol. 3, No. 3, 269-76 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 274-80 (May-June, 1958).

A discussion and tabulation of the limitations on the arbitrary assignment of three structure amplitudes connected with the use of other than inversion symmetry in the direct method of analysis.

539.2 : 548.7

12031 THE POSSIBILITIES OF STRUCTURAL ANALYSIS OF CRYSTALS.

A.A.Levin.

Kristallografiya, Vol. 3, No. 6, 655-8 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 663-6 (Jan., 1960).

The possibilities of trial-and-error methods are discussed. The number of atoms in the unit cell beyond which the structure cannot be completely solved and the maximum number of atoms in the unit cell for which structural analysis is still worthwhile are derived. No method can exceed the possibilities of trial-and-error methods, and the computed "limits" must, in a sense, be the limits of structural analysis in general.

539.2 : 548.7

12032 FUNCTIONAL PROJECTIONS FOR STRUCTURAL ANALYSIS OF CRYSTALS.

B.K.Vainshtein.

Kristallografiya, Vol. 3, No. 6, 659-63 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 667-71 (Jan., 1960).

The functional projection is the projection of the product of the electron density $\rho(xyz)$ and an arbitrary "projecting" function $f(xyz)$. Such a projection may be calculated from the sum of generalized projections and the Fourier coefficients from the decomposition of $f(xyz)$. All the known ones, and the new forms of projections proposed here, may be considered different versions of functional projections.

539.2 : 548.7

12033 NORMAL AND BOUNDED GENERALIZED ELECTRON-DENSITY PROJECTIONS WITH THE ORIGINAL PHASE.

I.M.Rumanova.

Kristallografiya, Vol. 3, No. 6, 664-75 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 672-83 (Jan., 1960).

Generalized projections of the type

$$C_L(x,y,Z) = \int_0^c \rho(x,y,z) \cos\frac{2\pi L}{c}(z-Z)\,dz$$

and

$$S_L(x,y,Z) = \int_0^c \rho(x,y,z) \sin\frac{2\pi L}{c}(z-Z)\,dz$$

are proposed. It is possible from such projections to determine all three coordinates of the atoms from data from a moving film of one layer line, and in particular to define the x and y coordinates of atoms which overlap in the xy projection (the method is only inapplicable in the case of atoms I and II where $z_i/c - z_{ii}/c = 1/2$). In cases where there is a mirror plane of symmetry perpendicular to the c axis, it is proposed to use phased projections of the type

$$C_L^{[0\,\frac{c}{2}]}(x,y,Z) = \int_0^{c/2} \rho(x,y,z) \cos\frac{2\pi L}{c}(z-Z)\,dz$$

$$S_L^{[0\,\frac{c}{2}]}(x,y,Z) = \int_0^{c/2} \rho(x,y,z) \sin\frac{2\pi L}{c}(z-Z)\,dz$$

(if there is two-fold screw axis 2_1 along c, displacing the centre of symmetry from the mirror plane by c/4, then the integration is carried out within the range from c/4 to 3c/4). Formulae are deduced for bounded generalized electron density projections

$$C_L^{[0\,\frac{c}{2}]}(x,y),\ ,\ S_L^{[0\,\frac{c}{2}]}(x,y),\ C_L^{[\frac{c}{4}\,\frac{3c}{4}]}(x,y),\ \text{and}\ S_L^{[\frac{c}{4}\,\frac{3c}{4}]}(x,y).\ .$$

Data from three layer lines on moving films taken about the c axis are required to construct these.

539.2 : 548.7

12034 X-RAY STRUCTURE CALCULATIONS ON THE "STRELA" UNIVERSAL COMPUTER.

A.A.Levin and M.A.Porai-Koshits.

Kristallografiya, Vol. 4, No. 2, 157-62 (March-April, 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 2, 141-5 (Feb., 1960).

539.2 : 548.7

12035 AUXILIARY INTEGRALS FOR LATTICE SUMS.

A.A.Maradudin and G.H.Weiss.

J. chem. Phys., Vol. 31, No. 5, 1433 (Nov., 1959).

The integrals $\phi_n(x)$ defined by

$$\phi_n(x) = \int_1^\infty t^n e^{-zt} dt,$$

where n is an integer or half an odd integer, occuring frequently in physical applications. When n is an integer these integrals are perhaps better known as the auxiliary integrals $A_n(x)$ which are widely used in the calculation of molecular integrals. These have been tabulated extensively by Kotani et al. and by Gourary and Lynam. The principal application of the integrals $\phi_n(x)$ with n half an odd integer is to the evaluation of lattice sums. For this reason, and to complement the tables of these integrals for integer values of n the integrals $\phi_n(x)$ for x = 0.2(0.2) 20 and n = 0.5(1) 12.5 have been computed. These tables are not, however, given here.

539.2 : 548.7

12036 THE APPLICATION OF OPTICAL DIFFRACTION METHODS TO CRYSTAL STRUCTURE PROBLEMS.

H.Lipson.

Sci. Progr., Vol. 47, 692-700 (Oct., 1959).

A review of new developments in connection with application of optical diffraction methods to help determination of crystal structures by X-rays. Geometrical considerations for image forming devices are discussed for designs of an optical diffractometer. Basic theory of the method is reviewed and examples of diffraction patterns from punched hole units are illustrated. Sets of holes repeated on a lattice are described and the principles guiding the application of the method to crystal structure determination are reviewed. Future possibilities are discussed. S.Tolansky

539.2 : 548.7

12037 ALLEGED FORMATION OF AN INTERMEDIATE DIAMOND STRUCTURE ON HEATING DIAMOND.

F.A.Raal.

Nature (London), Vol. 185, 523 (Feb. 20, 1960).

Graphitization experiments are reported for diamond carried out at 1400°C. Silicon carbide X-ray diffraction spots are identified. In these experiments the diamonds were heated in fire-clay boats, essentially aluminium silicate. It is considered that the diamond reacts to give a surface contamination of silicon carbide. This was established by heating diamond on platinum. The extra spots were then absent. A further proof is shown by chemical treatment of the contaminated diamond. This then confirms that the diffraction spots reported by Seal earlier are indeed due to silicon carbide and not due to an intermediate carbon phase. S.Tolansky

539.2 : 548.7

12038 THE STRUCTURE OF SOLID HYDROGEN.

A.A.Galkin and I.V.Matyash.

Zh. eksper. teor.Fiz., Vol. 37, No. 6(12), 1831-2 (Dec., 1959). In Russian.

Recent X-ray results for solid hydrogen fail to distinguish between a possible tetragonal lattice (a = 4.5 A, c = 3.68 A) and a hexagonal one (a = 3.7 A, c = 6.42 A). The present authors have studied the anisotropy of nuclear magnetic resonance in monocrystalline hydrogen at 4.2° K, and compared it with the values predicted by Dukhin (Abstr. 11586 of 1960) for these two structures. The anisotopy observed is lower than either predicted value, owing probably to molecular rotation. The authors regard this result as favouring the tetragonal lattice. A more clear-cut decision should be obtainable below 1.5° K. I.D.C.Gurney

539.2 : 548.7

12039 ELECTRON DIFFRACTION STUDIES OF THIN SILICON LAYERS.

F.Rogowski.

Z. Elektrochem., Vol. 64, No. 2, 305-10 (1960). In German.

Ten maxima are observed and it is suggested that the layers comprise tetrahedral molecules consisting of five atoms, oriented in a regular manner. J.E.Caffyn

539.2 : 548.7

12040 THE CHANGE IN INTENSITY OF X-RAY REFLECTIONS FROM A SINGLE CRYSTAL OF CdS UNDER ILLUMINATION.

L.A.Smirnov and M.A.Rumsh.

Zh. tekh. Fiz., Vol. 29, No. 6, 799 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 719-20 (Dec., 1959).

In an attempt to improve upon the results obtained by Shuvalov (Abstr. 1738 of 1957) who used a photographic method, the authors have used the ionization method of recording to investigate the effect of illumination on the intensity of X-ray reflections from CdS. They conclude that Shuvalov's photographic method is not sufficiently accurate. R.Bullough

539.2 : 548.7

12041 THE INFLUENCE OF ILLUMINATION ON THE INTENSITY OF THE X-RAY REFLECTIONS FROM A CRYSTAL OF CdS.

M.A.Rumsh, Yu.N.Shuvalov and L.A.Smirnov.
Fiz. tverdogo Tela, Vol. 2, No. 2, 369-70 (Feb., 1960). In Russian.

X-ray measurements of the intensities of reflections from a single crystal of CdS showed variations in the relative intensities which altered with changes in the intensity of the primary irradiating beam. By shining a beam of light onto the recording film (covered with black paper) in the places where some of the reflected X-ray beams fell, the local heating due to the absorbed radiation could be varied. 1° change in temperature changed the blackening by about 1.5°. It was thus shown that the observed variations were an instrumental effect and not due to radiation-induced changes in the crystal. A.L.Mackay

539.2 : 548.7 : 538.2

STRUCTURE OF ALLOYS OF GADOLINIUM WITH TRANSITION ELEMENTS.

See Abstr. 11823

539.2 : 548.7

12042 DETERMINATION OF THE STRUCTURE OF InSe BY ELECTRON DIFFRACTION.

S.A.Semiletov.
Kristallografiya, Vol. 3, No. 3, 288-92 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 292-7 (May-June, 1960).

A complete determination of the crystal structure was made. It has a layered hexagonal lattice with a = 4.04, c = 16.90 kilo X-units; n = 4; the space group is D_{6h}^4—C6/mmc. The In and Se atoms occupy the 4(f) position with Z(In) = 0.157, Z(Se) = 0.102. The structure of InSe is composed of four-layer packets with the following sequence of layers: SeInInSe. These packets are in hexagonal packing BCBC (GaS type). Some of the reflections on the electron diffraction patterns are diffuse, indicating that errors in the distribution of the packets occur in the structure; instead of the ideal stacking BCBC..., some of the packets are in "incorrect" positions and form regions with packing of the ABC type.

539.2 : 548.7

12043 THE CUBIC NITRIDE OF MOLYBDENUM.

N.V.Troitskaya and Z.G.Pinsker.
Kristallografiya, Vol. 4, No. 1, 38-41 (Jan.-Feb., 1959). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 4, No. 1, 33-6 (Jan., 1960).

An electron diffraction investigation was carried out. By the potential synthesis method, it was established that this phase, depending upon the conditions of formation, contains a deficiency of molybdenum in comparison with the stoichiometric amount. On potential sections and on a difference synthesis, maxima were obtained corresponding to nitrogen atoms both in fixed positions (at the centre of the cell) and also distributed statistically (in the middles of the edges) in the ratio of the effective ordinal numbers $Z_N:Z_{Mo} = 1 : 18$.

539.2 : 548.7

12044 THE LATTICE PARAMETERS AND DENSITY OF RUBY.

J.P.Jan, S.Steinemann and P.Dinichert.
Helv. phys. Acta, Vol. 33, No. 2, 123-30 (1960). In French.

The density and lattice parameters of artificial ruby were measured as functions of chromium concentration between 0 and 2 wt.% Cr. They were found to increase linearly with the chromium concentration. Within the limits of experimental error, the X-ray densities are equal to the measured densities. The agreement between calculated and measured density changes confirms the substitutional character of chromium. The continuum elastic theory of lattice defects predicts the correct order of magnitude for the expansion of the lattice.

539.2 : 548.7

12045 THIN FILMS OF SILVER—CADMIUM ALLOY.

K.Bahadur and P.V.Sastry.
Nature (London), Vol. 186, 467 (May 7, 1960).

Alloys of near equi-atomic composition, in bulk, transform from body-centred-cubic structure to close-packed hexagonal structure at about 250°C. Thin films studied in a high temperature electron diffraction camera failed to transform at temperatures up to 300°C. Above this temperature cadmium tends to evaporate from the foils. J.Adam

539.2 : 548.7

12046 LOW-TEMPERATURE X-RAY DIFFRACTION STUDIES ON VANADIUM SESQUIOXIDE.

E.P.Warekois.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 346S-347S (May, 1960).

X-ray diffraction patterns and microphotographs were obtained from single crystals and powder samples of V_2O_3, cooled to liquid nitrogen temperature. The c axis, in the hexagonal unit cell, expanded $5.8 \times 10^{-6}/°C$ while the a axis contracted $22.9 \times 10^{-6}/°C$, over the range from room temperature to the transformation temperature of about minus 145°C. Below this temperature a microphotograph showed a typical martensitic structure. The low-temperature X-ray diffraction reflections split for all reflections except those of the (000*l*) type. The (000*l*) type reflections indicated a lattice contraction below the transformation. Those X-ray reflections that split showed expansions in the interplanar spacings. The low-temperature powder pattern could be indexed on the basis of a monoclinic unit cell; a = 8.57, b = 4.98 and c = 13.88 A with $\beta = 91.6°$.

539.2 : 548.7

12047 STRUCTURE AND MAGNETIC PROPERTIES OF $LiCuCl_3 \cdot 2H_2O$.

P.H.Vossos, L.D.Jennings and R.E.Rundle.
J. chem. Phys., Vol. 32, No. 5, 1590-1 (May, 1960).

This substance is found to possess a monoclinic lattice with constants a = 6.078, b = 11.145 and c = 9.145 A and $\beta = 108° 50'$. The space group is established as $P2_1/c$. It is found to contain $Cu_2Cl_6^{2-}$ ions. A ground state triplet state is confirmed by paramagnetic susceptibility measurements. The magnetic properties of some $CuCl_2$ complexes are then discussed. T.E.Peacock

539.2 : 548.7 : 538.2

12048 FERROMAGNETIC-ALLOY PHASES NEAR THE COMPOSITIONS Ni_2MnIn, Ni_2MnGa, Co_2MnGa, Pd_2MnSb, AND PdMnSb.

F.A.Hames.
J. appl. Phys., Suppl. to Vol. 31, No. 5, 370S-371S (May, 1960).

In a search for further examples of Heusler-type alloys, ferromagnetic alloys were found near the composition Ni_2MnIn, Ni_2MnGa, Co_2MnGa, Pd_2MnSb, and PdMnSb. The first four alloys are tentatively identified as having the L2 (Heusler)-type structure; PdMnSb, the Cl_1-type structure. Previous work has indicated that ferromagnetism in these types of alloys is associated with Mn—Mn distances in the range 4.17-4,37 A. The present work indicates that ferromagnetism persists with Mn—Mn distances as small as 4.08 A (Co_2MnGa) and as large as 4.42 A (PdMnSb); and that ferromagnetism disappears if the Mn—Mn distances become too large. Pd_2MnSb, with Mn—Mn distance 4.55 A, is only feebly magnetic at room temperature.

539.2 : 548.7

12049 THE ARRANGEMENT OF THE CARBON ATOMS IN THE AUSTENITE LATTICE.

V.N.Bykov and S.I.Vinogradov.
Kristallografiya, Vol. 3, No. 3, 304-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 308-11 (May-June, 1958).

The austenite, which was alloyed with manganese, was investigated by the neutron diffraction method. It is shown that the carbons occupy the octahedral voids of the austenite lattice.

539.2 : 548.7

12050 THE CRYSTAL STRUCTURE AND COMPOSITION OF CREDNERITE, $CuMnO_2$.

Yu.D.Kondrashev.
Kristallografiya, Vol. 3, No. 6, 696-9 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 703-6 (Jan., 1960).

The parameters of the monoclinic cell of synthetic crednerite have been refined. The formula $CuMnO_2$ assumed on the basis of crystal chemistry has been confirmed by the determination of the density and an analysis of the intensities of the lines. The structure of $CuMnO_2$ was found to consist of alternating layers of oxygen octahedra and trigonal prisms. The Mn^{+3} ions lie in the centres of the octahedra; the Cu^{+1} ions, on the midpoints of the vertical edges of the prisms.

539.2 : 548.7

12051

VALENCE AND DISTRIBUTION OF MANGANESE IONS IN FERROSPINELS. A.Miller.

J. appl. Phys., Suppl. to Vol. 31, No. 5, 261S-262S (May, 1960).

Anomalous values of the magnetic moments observed for ferrospinels containing manganese have suggested that on octahedrally ligated spinel sites the ion pair [$Fe^{+2}Mn^{+3}$] is more stable than [$Fe^{+3}Mn^{+2}$]. Such behaviour is opposed to that observed in aqueous solutions, and to what is usually expected in oxidic compounds. The magnetic measurements, however, cannot be interpreted unequivocally, since they can also be explained by invoking spin quenching, or deviations from the simple antiparallel spin-only coupling scheme such as Yafet—Kitell angular coupling. A crystallographic rather than a magnetic criterion was devised to elucidate the valence behaviour in these compounds. When a sufficient fraction of the octahedrally ligated spinel sites are occupied by Mn^{+3}, a macroscopic tetragonal distortion, due to the Jahn—Teller effect, occurs. For appropriately selected spinel systems, the compositions for which this distortion is observable at room temperature depend on whether [$Fe^{+3}Mn^{+2}$] or [$Fe^{+2}Mn^{+3}$] are the stably coexisting species. Various compositions in the system $Zn_{1-0.5x}Ge_{0.5x}[Fe_xMn_{2-x}]O_4$ were synthesized, and X-ray powder diffraction photographs were made to determine whether they were cubic or tetragonal. The findings confirmed that the stable ion pair on octahedrally ligated sites is indeed [$Fe^{+2}Mn^{+3}$]. Furthermore, the axial ratios observed for the tetragonal compositions are in good agreement with those calculated by Wojtowicz, provided that the valence assignment [$Fe^{+2}Mn^{+3}$] is assumed. The reversal of valence stability can be explained reasonably as arising from crystal field effects. There is evidence that on octahedrally ligated spinel sites at elevated temperatures, and on tetrahedrally ligated sites, the ion pair [$Fe^{+3}Mn^{+2}$] is more stable than [$Fe^{+2}Mn^{+3}$]. The method of predicting the actual valence and ionic distributions in manganese-containing ferrospinels is discussed.

539.2 : 548.7

12052

THE CRYSTAL STRUCTURE OF LINARITE, $PbCuSO_4(OH)_2$. H.G.Bachmann and J.Zemann.

Naturwissenschaften, Vol. 47, No. 8, 177 (1960). In German.

The crystal system is monoclinic with a = 9.81, b = 5.65 and c = 4.70 A, β = 104.7°. The unit cell consists of two formula units. The space group is $P2_1/m$. The structure consists of $Cu(OH)_2$ layers parallel to (010) and each Cu atom has four OH groups in a square around it (Cu—OH = 1.93 A). Two O atoms of the sulphate group complete a distorted octahedron (Cu—O = 2.62 A). Pb atoms are irregularly placed with respect to the O atoms and OH groups around them (Pb—OH = 2.49 A). The sulphate group has its usual dimensions. J.E.Caffyn

539.2 : 548.7 : 539.215

12053

SMALL ANGLE SCATTERING INVESTIGATION OF LUDOX MIXTURES.

R.H.Bragg, I.Corvin and J.W.Buttrey.

J. appl. Phys., Vol. 31, No. 7, 1183-7 (July, 1960).

Small-angle X-ray scattering measurements were made on distributions of particles prepared by mixing two silica sols of about 90 A and 190A mean particle diameter in varying proportions. The scattering at small angles arises predominantly from the larger particles, whereas the smaller ones control the scattering at large angles, as predicted by theory. Attempts to determine the size distribution by the graphical method of Jellinek et al. were unsuccessful, but Porod's result relating the scattering at large angles to the total surface area was verified. Bounds for the largest and smallest sizes were estimated from the experimental data by means of simple calculations based on the properties of the scattering function.

539.2 : 548.7

12054

SOME DATA ON CRYSTAL-CHEMICAL HYDROGEN. B.K.Vainshtein.

Kristallografiya, Vol. 3, No. 3, 293-7 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 298-302 (May-June, 1960).

The distances of hydrogen atoms from other atoms in crystal structures are described best by the following hydrogen-atom radii: ionic, 1.5 A; metallic, 0.41 A; covalent, 0.30-0.35 A. Deviations from additivity are observed in a series of cases; in particular, the C—H distance is found to depend upon the nature of the bonds to the carbon atom, and is about 1.12 A for the tetrahedral carbon atom. Consideration is given to some data which touch upon hydrogen bonds.

VARIOUS SOLID STRUCTURES

539.21

12055

PHASE TRANSITIONS AND COMPRESSIONS OF SOLID CH_4, CD_4 AND O_2. J.W.Stewart.

J. Phys. Chem. Solids, Vol. 12, No. 2, 122-9 (Jan., 1960).

The piston-displacement technique previously described by the author (1956) was applied to a study of phase transitions and isothermal compressibilities of solid CH_4, CD_4 and O_2 over the pressure range 0-19 000 kg/cm² and the temperature range 4-120° K. Phase transitions appear as discontinuities in V (first order) or in $(dV/dP)_T$ (second order). Solid CH_4 and CD_4 both show three phases and one triple point. The transitions appear to be of the second order, with rather large "regions of indifference". There are isotopic differences between the two methanes. At atmospheric pressure CH_4 shows only one of the transitions, at 20.5° K, while CD_4 has both, at 22.1° and 27.2° K. There is at present disagreement between the present results for CH_4 and those obtained by Stevenson (Abstr. 431 of 1958). In the case of solid oxygen, the two well-known transitions have been traced to high pressure. The lower transition is evidently of the second order. The upper first-order transition has a large volume discontinuity. Some difficulty was experienced from ignition of the steel pressure chambers by the solid oxygen under high pressure. Pressure—volume relations for the three substances have been obtained at various temperatures.

539.21

12056

SOME PHYSICAL PROPERTIES OF NEPTUNIUM METAL II. A STUDY OF THE ALLOTROPIC TRANSFORMATIONS IN NEPTUNIUM.

J.A.Lee, P.G.Mardon, J.H.Pearce and R.O.A.Hall.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 177-81 (Oct., 1959).

For Pt. I, see Abstr. 2789 of 1960. The phase transformations in neptunium metal have been studied by thermal analysis, dilatometry, and resistivity measurements. The values obtained were: $\alpha \rightarrow \beta$ 280 ± 5°C; $\beta \rightarrow \gamma$ 577 ± 3°C; and $\gamma \rightarrow$ liquid 637 ± 2°C. Results of the X-ray examination of the crystal structures of the three phases are compared with those of Zachariasen (Abstr. 9179 of 1952).

539.213

12057

ANTISYMMETRY OF TEXTURES. A.V.Shubnikov.

Kristallografiya, Vol. 3, No. 3, 263-8 (1958). In Russian. English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 3, 269-73 (May-June, 1958).

The antisymmetry of textures with infinity-fold symmetry axes can be described in terms of thirteen limiting point groups. Five of these groups admit enantiomorphism, i.e. the existence of right-handed and left-handed textures derived from each other by a simple reflection in a plane. Two groups admit a special "sign" enantiomorphism, i.e. the existence of texture modifications which can be transformed one into another by sign change in all particles of the texture.

539.213

12058

THE INFLUENCE OF THE MEDIUM ON THE AMORPHISATION OF QUARTZ IN THE PROCESS OF ITS MECHANICAL DISPERSION.

G.S.Khodakov and P.A.Rebinder.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 6, 1316-18 (April 21, 1960). In Russian.

Quartz was milled with 80% and 1.2% water and in dry air. The specific surface was determined by the BET method, and the content of amorphous phase by differential thermal analysis. The X-ray scattering of quartz milled for a long time was compared with that of molten quartz and showed some similarities. Estimates are made of the thickness of the amorphous layer on the quartz particles and the role of plastic deformation in the formation of the amorphous layer is discussed. R.F.S.Hearmon

539.213

12059

THE ENERGY BALANCE OF VITRIFICATION AND CRYSTALLIZATION. A.Winter.

C. R. Acad. Sci. (Paris), Vol. 250, No. 18, 3000-2 (May 2, 1960). In French.

It is concluded that, on the grounds of the approximate equality of the enthalpy changes of the processes, the sudden change in C_p observed during slow cooling represents a real physical phenomenon associated with vitrification. P.Gray

539.213

12060 VITRIFICATION OF LIQUIDS AND POLYMERS UNDER PRESSURE. V. FORMATION OF CONDENSED LASSES. N.I.Shishkin.

'iz. tverdogo Tela, Vol. 2, No. 2, 350-7 (Feb., 1960). In Russian.

A dilatometric apparatus is described in which substances are ubjected to cycles of pressure (up to about 5000 kg/cm^2) and tem- erature (up to about 250° C). Results are reported for the fractional olume change $\Delta v/v$ under these conditions of rosin, phenolphthalein, olystyrene, polymethylmethacrylate and boron oxide. The results how that compression of supercooled liquids and polymers and ubsequent cooling under pressure lead to the formation of glasses ith density near to that corresponding to the equilibrium state of ie material. R.F.S.Hearmon

539.213

12061 VITRIFICATION OF LIQUIDS AND POLYMERS UNDER PRESSURE. VI. DEPENDENCE OF VOLUME OF CON- ENSED GLASSES ON TEMPERATURE.

I.Shishkin and O.F.Kovalichev.

'iz. tverdogo Tela, Vol. 2, No. 2, 358-60 (Feb., 1960). In Russian.

See preceding abstract. The quantity $(1 + \Delta v/v)$, where v is the olume at 20° C, is shown plotted against temperature for normal lasses (obtained by cooling at atmospheric pressure) and condensed lasses (obtained by cooling under hydrostatic pressure) of phenol- hthalein, polystyrene, polymethylmethacrylate and boron oxide. R.F.S.Hearmon

539.213 : 539.2 : 537.311

12062 GLASSY SEMICONDUCTORS. VII. VISCOSITY OF VITREOUS SEMICONDUCTORS IN THE As_2Se_3—As_2Te_3 YSTEM. B.T.Kolomiets and V.P.Pozdnev.

iz. tverdogo Tela, Vol. 2, No. 1, 28-34 (Jan., 1960). In Russian.

Compositions between As_2Se_3 and $As_2Se_3.As_2Te_3$ were studied 00-800° C) by a rotational method. Kinematic viscosity (ν) de- reased smoothly with As_2Te_3 concentration (x) and with tempera- ıre (at ~ 400° C it varied from ~ 10^2 to 10^{-1} stokes; at ~ 700° C from 10^{-1} to 10^{-2} stokes). Activation energies (E) for viscous flow were valuated (24.3-21.8 kcal/mole, decreasing with increasing x) as ere the corresponding entropies of activation (in the range +7.2- 75 cal/deg.mole). This behaviour was interpreted in terms of a ain structure: the low softening temperatures (< 200° C) were scribed to the breaking of interchain Van der Waals bonds, and the onstant E for a given composition to the breaking of intrachain co- lent bonds. (See also Abstr. 1048 of 1958; 3454 of 1959; 601, 3263 1960). C.H.L.Goodman

539.214

12063 APPLICATION OF THE METHOD OF HARMONIC EXCITATION TO THE MEASUREMENT OF THE ECHANICAL AND PHOTOELASTIC CHARACTERISTICS OF A LASTIC MATERIAL. A.Lagarde.

.R. Acad. Sci. (Paris), Vol. 250, No. 16, 2796-8 (April 20, 1960). French.

The material used is Araldite. Brief details of the theory are ven and results giving constants which are related to the rigidity ıd the damping characteristics are presented. The photoelastic onstant is stated to be 54 ± 2.5 Brewsters and is independent of e frequency of oscillation. H.G.Jerrard

539.214

12064 REVERSIBLE CHANGES IN THE PERMEABILITY OF POLYMERS TO GAS DURING GAMMA IRRADIATION.

.S.Tikhomirova, Yu.M.Malinskii and V.L.Karpov.

okl. Akad. Nauk SSSR, Vol. 130, No. 5, 1081-4 (Feb. 11, 1960). Russian.

Polyethylene films of 90 and 120μ, only slightly permeable to e and Xe in the experimental conditions chosen, remained so when radiated at a dose of 100 rad/sec. At higher doses the perme- ility ratio (for He) increased to ~ 3 at 300 rad/sec, and ~ 10 at 0 rad/sec. This effect was almost completely reversible, only a nall after-effect being noticed. A slightly greater effect was ob- erved for Xe. Similar phenomena were found for polytetra- uoroethylene. F.Lachman

539.214

12065 STUDY OF THE SUBMICROSCOPIC POROSITY OF DEFORMED POLYMERS.

N.Zhurkov, V.A.Marikhin and A.I.Slutsker.

iz. tverdogo Tela, Vol. 1, No. 7, 1159-64 (July, 1959). In Russian.

The investigation of the phenomenon of cloudiness in the deformed polymers (polymethyl methacrylate, nitrocellulose, polychlorovinyl, di and triacetate of cellulose, "butafol" film, "styroflex", etc.) by various physical methods (dispersion of light, small-angle dispersion of X-rays, dilatometry) shows that submicroscopic discontinuities (cracks) appear at certain conditions in specimens deformed by tension. Very early stages of the breakdown process can be examined by using advanced experimental techniques. F.Lachman

539.214

12066 SOLUBILITIES AND DIFFUSIVITIES OF NITROGEN IN POLYETHYLENE.

J.L.Lundberg, M.B.Wilk and M.J.Huyett.

J. appl. Phys., Vol. 31, No. 6, 1131-2 (June, 1960).

The paper gives the results of experiments in which nitrogen is absorbed into polyethylene contained in a sintered glass or steel cylinder. This is placed in a high pressure system of known volume and held at a steady temperature. E.G.Knowles

539.215

12067 THE HYDRAULIC RESISTANCE OF ION-EXCHANGE RESINS. V.V.Rachinskaya.

Zh. tekh. Fiz., Vol. 29, No. 9, 1159-61 (Sept., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 9, 1057-9 (March, 1960).

The rate of percolation of water under a constant hydrostatic head for a definite weight of water-swelling ion-exchange resin packed in glass tubes of 5-10 mm diameter was compared with the rate of percolation through sand. Similar results were obtained with the two types of filter bed both under laminar and turbulent flow conditions, when a form factor was applied to the results obtained with sand to allow for the irregular shape of the sand grains. R.Schnurmann

539.215 : 539.2 : 548.7

PARTICLE SIZE OF SILICA SOLS AND X-RAY SCATTERING.

See Abstr. 12053

539.216

12068 ELECTRON MICROSCOPIC STUDY OF THIN FILMS OF THE ALUMINUM—COPPER EUTECTIC PREPARED BY A MELTING METHOD. N.Takahashi.

J. appl. Phys., Vol. 31, No. 7, 1287-90 (July, 1960).

Thin films of the Al—Cu eutectic (67 wt % Al, 33 wt % Cu) were prepared by the melting method previously described and examined by electron microscopy. The lamellar structure of this eutectic was revealed so clearly that the contrast of the image obtained was comparable to that obtained by a replica method which proved that the present film represented the same structure as the massive specimen. Electron-diffraction study revealed which lamella belongs to the κ or θ phase and permitted the determining of the relative crystal orientation between two types of lamellae.

539.217

12069 PERMEABILITY AND DIFFUSIVITY OF HYDROGEN THROUGH A PALLADIUM TUBE.

O.M.Katz and E.A.Gulbransen.

Rev. sci. Instrum., Vol. 31, No. 6, 615-17 (June, 1960).

A palladium diffusion tube which supplies high purity hydrogen was constructed for use in a high vacuum glass system. Temperatures of 213°-379° C and back pressures from 1 to 2 atm H_2 were used. In this range the permeability was proportional to the square root of pressure and an exponential function of reciprocal temperature. The tube has a long life if it was kept above 150° C while exposed to the gas. Diffusion coefficients obtained from the permeability experiments were in very good agreement with previous results. The equation for diffusion was $D_H = 4.3_1 \times 10^{-3} e^{-5600/RT}$ The large amounts of hydrogen obtained were reproducible to ±2% of the mean.

539.219

12070 SELF-DIFFUSION AND HETERODIFFUSION IN NON-HOMOGENEOUS POROUS BODIES. III. OCCURRENCE OF THE FRENKEL AND KIRKENDALL EFFECTS IN THE SINTERING OF SPECIMENS OF POWDER MIXTURES OF MUTUALLY DIFFUSING METALS. B.Ya.Pines and A.F.Sirenko.

Zh. tekh. Fiz., Vol. 29, No. 5, 653-61 (May, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 5, 582-9 (Nov., 1959).

A theoretical analysis of the phenomenon of growth, as observed during the sintering of mixtures of powders of mutually diffusing metals, is given assuming the growth is due to the Frenkel effect. The theory is compared with some observations on the Ni–W, Cr–Mo and Cu–Ni systems and in consequence it is suggested that the unequal partial diffusion in porous "metalloceramics" leads primarily to the Frenkel effect and not to the Kirkendall effect. For Pt II, see Abstr. 6307 of 1959. R.Bullough

539.219

12071 ON THE CONFIGURATION FREE ENERGY OF KCl–KBr SOLID SOLUTIONS. V.Hovi.

Ann. Univ. Turku AI, No. 34, 6 pp. (1959).

Values for the configurational free energy were calculated for different compositions and temperatures. The curves obtained seem to be continuous, with one extreme point. No deformation, similar to that of the free energy curves, can be observed at temperatures $T \geq 198.2°K$. Reference was made to the recent X-ray work of Nurmia [Suomen Kemistilehti B, Vol. 32, 25 (1959)] according to which the critical mixing temperature of the system KCl–KBr ought to be at temperatures below 183.2°K.

539.219

12072 ENTROPY OF LONG RANGE ORDER IN β-BRASS. V.Hovi and K.Mansikka.

Ann. Univ. Turku A I, No. 34, 5 pp. (1959).

Calculated using a certain combinatory number (cf Abstr. 309 of 1940) and experimental specific heats. The results obtained are in good agreement with each other. Thus, the combinatory number used for calculations seems to be a good approximation.

539.219

12073 ELECTRONIC SPECIFIC HEAT OF α AND β-BRASSES AT LOW TEMPERATURES. V.Hovi and K.Mansikka.

Ann. Acad. Sci. Fennicae A VI, No. 25, 8 pp. (1959).

Investigated as functions of composition, by applying Sommerfeld's theory and making an assumption concerning the free electrons. It is shown that the theoretical values obtained are in good agreement with the experimental data of Rayne (Abstr. 161 of 1958) in the case of α-brass. For β-brass, however, a similar comparison cannot be made because suitable experimental data seems to be still lacking.

539.219

12074 THE PROBLEMS OF THE DETERMINATION OF THE NUMBER OF INDEPENDENT PARAMETERS OF LONG-RANGE ORDER FOR MANY-COMPONENT ALLOYS. A.N.Men'.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 633-5 (1959). In Russian.

The problem is to find the number of independent terms of the matrix $[N_i^j]$, where N_i ($i = 1,2,\ldots m$) is the number of atoms of type i and N^j ($j = 1,2\ldots m_1$) is the number of lattice sites of type j. For the special case $m = m_1 = n$ the number of independent parameters is $(n-1)^2$ in agreement with Wojciechowski [Acta phys. Polon., Vol. 15, No. 6, 429 (1956)]. A.F.Brown

539.219

12075 THE QUESTION OF THE INFLUENCE OF ANNEALING ON THE PHYSICAL PROPERTIES OF SOLID SOLUTIONS OF ALKALI HALIDE SALTS.

E.K.Zavadovskaya, M.S.Ivankina and I.Ya.Melik-Gaikazyan.

Fiz. tverdogo Tela, Vol. 2, No. 4, 665-9 (April, 1960). In Russian.

Mixed crystals (KCl–KBr and NaCl–NaBr) were heated at 600°C for periods up to 75 hours. The densities, cell parameters, molecular concentrations, numbers of particles per cell, thermal expansions and relative thermal conductivites of the annealed specimens were determined. Pore and fissure formation are discussed and illustrated by photographs. Annealing leads to a rearrangement of vacancies in the crystals with a slight increase in density. R.F.S.Hearmon

539.219

12076 THE NATURE OF A HIGH-TEMPERATURE PHASE TRANSITION IN CERTAIN $BaTiO_3$–$BaSnO_3$ SOLID SOLUTIONS. S.V.Bogdanov and R.Ya.Razbash.

Fiz. tverdogo Tela, Vol. 2, No. 4, 670-2 (April, 1960). In Russian.

Investigations of ferroelectric polycrystalline solid solutions $BaTiO_3$–$BaSnO_3$, containing 5, 7.5, 10 and 15% $BaSnO_3$, showed that a phase transition in the Curie region is more likely to be of the first than of the second type. A.Tybulewicz

539.219

12077 X-RAY INVESTIGATION OF THE SYSTEM TELLURIUM–SELENIUM. T.P.Smorodina.

Fiz. tverdogo Tela, Vol. 2, No. 5, 883-6 (May, 1960). In Russian.

On the assumption that Te and Se form a series of substitutional solid solutions, the theoretical density of Te–Se alloys was calculated (with up to 75 at% Se) from the X-ray data on the lattice parameters a and c, their real density determined by the pycnometric method, and the number of atoms per unit cell calculated. Both a and c decreased with increasing Se content, but only c obeyed Vegard's law; the a versus concentration and density versus concentration curves had a minimum and a maximum respectively. Although no evidence of the existence of a superstructure was found, a complex structure of the Te–Se alloys was postulated, its having been concluded that Te and Se form neither substitutional nor interstitial solid solutions. M.H.Sloboda

539.219

12078 ON THE KINETICS AND MECHANISM OF THE PRECIPITATION OF LITHIUM FROM GERMANIUM.

J.R.Carter, Jr and R.A.Swalin.

J. appl. Phys., Vol. 31, No. 7, 1191-1200 (July, 1960).

The kinetics of precipitation of lithium from germanium were investigated and the following variables were studied: (a) crystal source; (b) preannealing treatments prior to the introduction of lithium; (c) the effect of selective impurity additions, namely, oxygen and copper. The precipitation process can be described as following the law given below:

$$\log C/C_0 = \exp[-(t/\tau)^n].$$

Upon saturation at elevated temperatures (about 425°C), n is found to be $\frac{3}{2}$ for the first part of the process and 1 for the later part of the process. Upon saturation at low temperatures, however, n is found to be $\frac{1}{2}$. It is suggested that this results from the nonuniform distribution of lithium in the crystal prior to precipitation. Nucleus number densities varying by orders of magnitude were obtained from different crystals. It was found that a preannealing treatment at 900°C was sufficient to increase the nuclei number densities for all crystals and the differences tend to disappear upon the preannealing treatment. Doping with oxygen tended to increase very markedly the number density of nuclei, whereas doping with small amounts of copper (several orders of magnitude less than lithium present) decreased the number density of nuclei by about an order of magnitude. Interpretation of these results suggests that an impurity, consisting either of particles or oxygen-vacancy pairs, is catalysing the precipitation process.

539.219

12079 PREPARATION AND PROPERTIES OF AlSb–GaSb SOLID SOLUTION ALLOYS.

J.F.Miller, H.L.Goering and R.C.Himes.

J. Electrochem. Soc., Vol. 107, No. 6, 527-33 (June, 1960).

Ingots of the quasi-binary GaSb–AlSb alloy were prepared by progressive casting and zone casting at various rates of crystallization. Results of X-ray diffraction studies, metallographic studies, hardness determinations, and chemical analyses indicate that, with the possible exception of a narrow composition range between 20 and 30 mole % AlSb which was not investigated, solid solution prevails in the system. Bulk specimens of single phase, solid solution alloy were obtained by use of low linear rates of crystallization (0.05 in./hr), while at higher rates of crystallization ($\frac{1}{4}$ to $1\frac{1}{4}$ in./hr) two intermingled solid phases were characteristically obtained. Vegard's law was found to be at least roughly applicable; with lattice constants for the alloys ranging between values of 6.0963 A for pure GaSb and 6.1361 A for pure AlSb. Optical energy gaps determined for alloy specimens increased regularly with cell size from a value of 0.68 eV for GaSb to a value of 1.74 eV for AlSb. Values of electrical resistivity and hole mobility for the relatively impure alloy specimens wer also intermediate between those for the compounds in a like state of purity. Liquidus data are also presented for the system.

539.219

12080 SOLID SOLUBILITIES OF ALUMINUM AND GALLIUM IN GERMANIUM.

F.A.Trumbore, E.M.Porbansky and A.A.Tartaglia.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 239-45 (Oct., 1959).

Crystal-pulling and thermal-gradient crystallization techniques have been used to determine the solid solubilities of aluminum and gallium in germanium in the ranges from 500 and 300°C, respectively, to the melting point of germanium. Both elements have maximum solubilities of the order of 1 atomic per cent. In addition, these systems are characterized by a relatively rapid variation of the distribution coefficient with temperature near the melting point of germanium. The form of the temperature-dependence of the distribution coefficient can be interpreted qualitatively in terms of departures from ideality in the liquid phase and of the effects due to ionization of these acceptor impurities in solid solution.

539.219

12081

DETERMINATION OF THE COMPOSITION AT CONGRUENT FUSION OF BINARY SEMICONDUCTORS BY DIFFERENTIAL THERMAL ANALYSIS. APPLICATION TO Bi_2Te_3, Sb_2Te_3 and Bi_2Se_3.

G.Offergeld and J. Van Cakenberghe.

J. Phys. Chem. Solids, Vol. 11, No. 3-4, 310-14 (Oct., 1959). In French.

The phase diagram of binary compounds is generally characterized by the existence of a maximum in the liquidus curve for a composition near the stoichiometric composition and by isothermal ransitions corresponding to the melting of eutectic phases or to peritectic reactions. The amount of heat involved in these transiions is a linear function of the difference between the actual composition and the composition having a congruent melting point. By differential thermal analysis it is possible to determine the composition for which these thermal effects disappear and thus to measure the difference between the congruent and stoichiometric compositions.

539.219

12082

REGULAR SOLID SOLUTIONS WITH MOLECULES OCCUPYING SEVERAL SITES.

T.S.Chang.

Science Record (China), New Series, Vol. 3, No. 12, 631-4(Dec., 1959).

The partition function for such systems can be derived by aking a group of neighbouring lattice points as a single site, assuming an infinite interaction energy between molecules which occupy overlapping sites, and using the methods developed for ordinary solid solutions (Abstr. 6441 of 1958). Expressions are given for a binary solid solution, in which one member consists of molecules occupying two sites, for cubic lattices. J.Hawgood

539.219

12083

SOLID SOLUTION IN $A^{II}B^{VI}$ TELLURIDES.

J.C.Woolley and B.Ray.

J. Phys. Chem. Solids, Vol. 13, No. 1-2, 151-3 (May, 1960).

Alloys have been produced for the three systems CdTe—HgTe, CdTe—ZnTe and HgTe—ZnTe and annealed to obtain equilibrium conditions. It has been confirmed that solid solution occurs at all compositions in each system and the variation of lattice parameter with composition has been determined in each case. The form of the solidus curve has been obtained by X-ray methods in the HgTe—ZnTe system.

539.219

12084

EFFECTS OF IRRADIATION ON SOME CORROSION-RESISTANT FUEL ALLOYS.

J.H.Kittel, S.Greenberg, S.H.Paine and J.E.Draley.

Nuclear Sci. Engng, Vol. 2, No. 4, 431-49 (July, 1957).

Three corrosion-resistant uranium-base alloys, [U—3 wt.% Nb, U—5 wt.% Zr—$1\frac{1}{2}$ wt.% Nb, and U—3.8 wt.% Si (U_3Si)] were irradiated to burnups of 0.1 at.% or less. Observations were made of irradiation-induced length changes in specimens of the alloys as influenced by the method of fabrication and heat treatment, and of changes in aqueous corrosion resistance resulting from irradiation. t was found that the uranium—niobium alloy was unsuitable from the standpoint of dimensional and surface stability, and its corrosion resistance was destroyed by irradiation. The uranium—zirconium—niobium alloy could be nominally stabilized under irradiation and its corrosion resistance was destroyed by between 0.046 and 0.074 at.% burnup. The uranium—silicon alloy was relatively stable under irradiation and showed no increase in corrosion rate at 290°C after 0.090 at.% burnup, although cracking occurred after several days corrosion testing.

539.23

12085

THE MEASUREMENT OF SMALL DIFFERENCES IN FILM THICKNESS IN NON-METALLIC THIN FILMS.

G.Koppelmann.

Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 7-8, 397-404 (1960). In German.

The distribution of thickness variation in thin dielectric films which exhibit only small local thickness variations can be measured because the local reflectivity is dependent on local film thickness. The experimental arrangement used is described. The technique is applied to the examination of evaporated cryolite films. The evaporation charcteristics of the evaporation furnace can be determined from the thickness variations observed. Contour maps are shown on a film of thickness 1100 A and the method shows local variations appearing in a regular manner, down to differences of 57 A. The influence of dispersion is discussed. S.Tolansky

539.23

12086

STRUCTURAL CHANGES IN THIN TUNGSTEN FILMS.

A.I.Andrievskii and I.D.Nabitovich.

Fiz. tverdogo Tela, Vol. 2, No. 5, 982-6 (May, 1960). In Russian.

The energy of the electron beam in an electron microscope is utilized for the thermal treatment of tungsten films. Electron diffraction diagrams and photographs of the films are reproduced. The reduction of WO_3 to WO_2 takes place through two intermediate oxides, and of WO_2 to α—W through β—W. The results show that crystals of α—W are rhombododecahedrons, those of WO_2 are trigonal pyramids on tetrahedra, and those of WO_3 are rhombic prisms. R.F.S.Hearmon

539.23 : 621.382

12087

THE GROWTH OF ANODIC OXIDE FILMS ON GERMANIUM.

S.Zwerdling and S.Sheff.

J. Electrochem. Soc., Vol. 107, No. 4, 338-42 (June, 1960).

Thick uniform germanium dioxide films of controlled thickness have been grown anodically on both n- and p-type germanium. The electrolyte used was a 0.25N solution of anhydrous sodium acetate in glacial acetic acid. The composition of the films was established by gravimetric and spectrometric methods. From the current efficiencies and the other parameters of the electrolysis, certain significant properties of the oxide films were calculated, i.e. differential formation field during growth, resistivity, and thickness. Furthermore, it was possible to determine changes in these quantities by evaluating them for different intervals of the electrolysis.

539.23

12088

EXTENDED THEORY OF SPUTTERING.

D.E.Harrison, Jr.

J. chem. Phys., Vol. 32, No. 5, 1336-41 (May, 1960).

The author's earlier theory of sputtering (Abstr. 4806 of 1957) is simplified to a form from which direct computations are possible without extended numerical analysis. A considerable analytic simplification is obtained by a new choice of boundary conditions, and certain mathematical expressions have been modified by physical considerations where a detailed analysis is not justified by the present state of experimental information. The special cases of very high and very low energy sputtering are examined in some detail. The $(\ln E_0)/E_0$ high-energy results of Goldman and Simon are shown to be fortuitous but still significant. Low energy results are of the form reported by Wehner.

X-ray and Electron Microscope Examination

539.26

12089

THE ANALYSIS OF LONG-PERIOD INTERFERENCES.

R.Bonart and R.Hosemann.

Z. Elektrochem, Vol. 64, No. 2, 314-21 (1960). In German.

In order to account for small-angle diffraction patterns of synthetic fibres, a model is proposed consisting of randomly bent layers. A optical analogue was used to confirm that this model would give the correct diffraction pattern. A.R.Stokes

539.26 : 531.72

MEASUREMENT OF THIN METAL LAYERS. FLUORESCENT X-RAY PRODUCTION BY RADIOSOTOPE SOURCES.

See Abstr. 10630

539.27

12090

PREPARATION OF TIN SINGLE CRYSTALS FOR TRANSMISSION ELECTRON MICROSCOPY.

J.T.Fourie, F.Weinberg and F.W.C.Boswell.

J. appl. Phys., Vol. 31, No. 6, 1136 (June, 1960).

An electropolishing technique for thinning down single crystals of tin by two stages is described. In the first stage a rapid dissolution of the specimen down to a thickness of 0.2 mm is obtained. In the next each side of the specimen is dealt with in turn and until holes appear in the centre of the specimen while a mirror like polish is obtained. Details regarding the electrolytic process are given. Material near the edges of the holes was generally sufficiently thin for electron transmission. The single crystal nature of the foils is preserved and they were later examined with special reference to the formation and growth of twins. An example is illustrated. R.S.Read

539.27

12091 SIZE DISTRIBUTION OF TOBACCO SMOKE DROPLETS BY A REPLICA METHOD. W.J.Harris.

Nature (London), Vol. 186, 537-8 (May 14, 1960).

The true diameters of smoke droplets obtained directly by precipitator methods are compared with those of spread-out droplets sampled on a wet gelatine film and examined by replication microscopy. Spreading always occurs on the sampling surface, hence spread diameters cannot be used directly if accurate size distribution data are needed. R.Reed

539.27

12092 CONTRAST SHADOWCASTING OF DISLOCATION ETCH PITS IN LiF SINGLE CRYSTALS FOR ELECTRON MICROSCOPICAL EXAMINATION. E.Shüller.

Z. Naturforsch., Vol. 15a, No. 2, 169 (Feb., 1960). In German.

The shape of the etch pits in lithium fluoride can be best shown up in the electron microscope if the direction of shadowcasting of the replica is properly related to the orientation of the crystal lattice. When aqueous ferric chloride is the etchant, this direction should be normal to the (100) direction. When the etchant is CP-4, a double shadowing method is recommended. V.E.Cosslett

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

541.12

12093 ON A QUANTUM MECHANICAL THEORY OF ABSOLUTE REACTION RATES. S.Golden.

Nuovo Cimento Suppl., Vol. 15, No. 3, 335-73 (1960).

Time independent species classification operators introduced for microscopic systems allow the construction of composition operators for macroscopic systems. Construction of dynamical variables from the latter give rise to operators for the time rate of change of the composition of the mixture. Introduction of the statistical matrix leads to rate expressions analogous to the fundamental equations of chemical kinetics which allow various identifications to be made. A variational problem is considered in which the statistical matrix and the species classification operators are varied, and the results of the theory of absolute reaction rates are discussed in the light of other theories. R.A.Ballinger

541.12 : 530.16

12094 CLUSTER THEORY OF CONDENSING SYSTEMS. K.Ikeda.

Progr. theor. Phys., Vol. 19, No. 6, 653-98 (June, 1958).

A detailed and rigorous theory of vapour–liquid coexistence in the condensation of a system consisting of a very large number (N) of interacting molecules (in a volume Nv). Starting from the Ursell–Mayer expansion of the partition function, certain ordinary assumptions are made about the cluster integrals (b_l). First a function $l^*(N)$ is taken which satisfies certain conditions, and "small" clusters [for which $l \leq l^*(N)$] and "large" clusters [for which $l > l^*(N)$] are defined; thus all clusters in the system (for each N) are classified into "small" and "large" clusters, and the partition function (Ω_N) of the system (for each N) is expressed in terms of the factors (φ_N) which contain "small" clusters only and the factors (Φ_N) which contain "large" clusters only. It is then proved that an assembly of molecules divided into any number of "large" clusters may be replaced by only one "larger" cluster composed of all the molecules of the assembly with errors as small as desired if N is sufficiently large. Further, it is proved that as soon as the density of the system exceeds that of the saturated vapour, the isotherm becomes horizontal and there appears one "huge" cluster, which is defined as a cluster for which l/N is as near to some positive constant as desired if N is sufficiently large. Thus the "huge" cluster is of a macroscopic size and should be considered to represent the liquid phase coexisting with the saturated vapour. It is shown that Mayer's theory of condensation has some defects, and an improved approximate theory is proposed in which these defects are avoided. The present theory is compared with the theory of Bose–Einstein condensation, and it is noted that the present theory is quite free from the faults contained in the saddle-point method.

541.12 : 533.7

VARIATIONAL PRINCIPLES FOR CHEMICAL EQUILIBRIUM.
See Abstr. 10690

541.12

12095 CLOSED CRUCIBLE — A NEW TECHNIQUE IN HIGH TEMPERATURE CHEMISTRY. ITS APPLICATION TO TANTALUM AND MOLYBDENUM OXIDES.

E.D.Cater, E.R.Plante and P.W.Gilles.

J. chem. Phys., Vol. 32, No. 4, 1269-70 (April, 1960).

An experimental technique for the study of vaporization is described and some results obtained on the Ta–O and Mo–O systems discussed. G.I.W.Llewelyn

541.12

12096 NUCLEATION OF AMMONIUM CHLORIDE PARTICLES FROM HYDROGEN CHLORIDE AND AMMONIA IN AIR.

S.Twomey.

J. chem. Phys., Vol. 31, No. 6, 1684-5 (Dec., 1959).

Data are given, and the experimental procedure briefly described. The results suggest that classical nucleation theory may be applied quantitatively to the formation of solid particles by reaction between vapours. A value of 130 erg cm^{-2} is computed for the free surface energy of NH_4Cl. W.Good

541.12

12097 RESULTS CONCERNING THE OXIDATION OF GERMANIUM SURFACES OF VARIOUS ORIENTATIONS, FOR TEMPERATURES VARYING FROM 500 TO 800°C AND OXYGEN PRESSURES OF 10^{-4} to 10^{-3} mm Hg. L.Gouskov.

C. R. Acad. Sci. (Paris), Vol. 250, No. 14, 2538-40 (April 4, 1960). In French.

Concerns oxidation at 500°C under 10^{-4} mm pressure of O_2 of (100), (110) and (111) faces, and at 600, 700 and 800°C under 10^{-3} mm pressure of O_2 of the (111) face. Careful preparation and electrolytic polishing gives a suitable surface. The type of corrosion depends on the amount of oxygen available and the formation of GeO or GeO_2. Seven plates. W.Bardsley

541.12

12098 REACTION PRODUCTS OF ATOMIC HYDROGEN WITH SOLID OZONE. P.A.Giguère and D.Chin.

J. chem. Phys., Vol. 31, No. 6, 1685-6 (Dec., 1959).

The (glassy) reaction products, supposed by some investigators to be H_2O_4, were examined by infrared absorption. In numerous experiments, the spectra, from 2 to 30 μ, proved to be identical with those of solid mixtures of $H_2O - H_2O_2$ plus three strong bands of unreacted ozone. W.Good

541.12

12099 MUTUAL SOLUBILITY OF HYDROGEN AND DEUTERIUM AT 4.2°K.

R.F.Bulatova, V.S.Kogan and V.G.Lazarev.

Zh. eksper. teor. Fiz., Vol. 37, No. 5(11), 1492-3 (Nov., 1959). In Russian.

X-ray data indicate that the limiting solubilities are: 10% for hydrogen in deuterium, and 21% for deuterium in hydrogen. S.Chomet

541.12

12100

THE EFFECT OF ALPHA-ACTIVITY ON THE CORROSION RATES OF PLATINUM AND ZIRCONIUM IN HBr.

D.M.Ziv and I.A.Efros.

J. nuclear Energy, Vol. 9, No. 1-4, 189-90 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 293 (1958).

The corrosion rate of Pt in 40-50% HBr is not markedly affected by α-radiation but that of Zr is increased some hundred times by 0.3 curie ml^{-1} of polonium in solution. This effect is attributed to the action of atomic bromine, hydrogen peroxide and other radiolysis products. Complete results are tabulated. G.I.W.Llewelyn

541.12

12101

EXPERIMENTAL ESTIMATE OF THE FREE ENERGY OF FORMATION OF PLUTONIUM TRIFLUORIDE.

A.G.Buyers and E.W.Murbach.

Nuclear Sci. Engng, Vol. 2, No. 5, 679-86 (Sept., 1957).

A study involving equilibration at 1573°K of fused uranium tetrafluoride and molten irradiated uranium has permitted calculation of the free energy of formation of plutonium trifluoride at 1573°K. During equilibration it is assumed that plutonium is extracted into molten uranium fluoride as represented by one of the following equations:

$$\mathrm{Pu}\ (l) + \tfrac{3}{4}\ \mathrm{UF_4}\ (l) \rightleftharpoons \mathrm{PuF_3}\ (l) + \tfrac{3}{4}\ \mathrm{U}\ (l)$$
$$\mathrm{Pu}\ (l) + \mathrm{UF_3}\ (s) \rightleftharpoons \mathrm{PuF_3}\ (l) + \mathrm{U}\ (l)$$

Free energy values for the formation of plutonium trifluoride are calculated from experimentally determined equilibrium and the free energy of formation of uranium tetrafluoride, using the expression:

$$\tfrac{1}{3}\ \Delta F^0(\mathrm{PuF_3}) = \tfrac{1}{4}\ \Delta F^0(\mathrm{UF_4})\ -2.3\ RT \log K_e.$$

The free energy of formation at 1573°K for $\mathrm{PuF_3}$ was found to be 93 ± 1.5 kcal/equivalent as compared to an estimated value of 94 kcal/equivalent at 1500°K based on earlier work by Brewer, Bromley, Gilles and Lofgren.

541.12

12102

REACTION KINETICS OF ZIRCONIUM AND ZIRCALOY-2 IN DRY AIR AT ELEVATED TEMPERATURES.

L.F.Kendall, R.G.Wheeler and S.H.Bush.

Nuclear Sci. Engng, Vol. 3, No. 2, 171-85 (Feb., 1958).

Corrosion rates of sponge zirconium and Zircaloy-2 in dry air were measured at 500, 600 and 700°C. The reaction proceeds in two stages: initially the rate decreases with exposure time, approximating a cubic relationship; after sufficient exposure, the rate becomes a linear function of time. The rate constants calculated from the data and expressed by the Arrhenius equation, $k = A \exp(-Q/RT)$, are:

Initial reaction

	A, $(\mathrm{mg/cm^2})^{2.58}$/hr	Q, cal/mole
Zircaloy-2	1.1×10^9	3.94×10^4
Zirconium	1.8×10^9	4.14×10^4

After transition

	A, $\mathrm{mg/cm^2}$/hr	Q, cal/mole
Zircaloy-2	8.5×10^6	3.10×10^4
Zirconium	7.4×10^5	2.98×10^4

Extrapolation of these data to lower temperatures shows that the service life of structures fabricated from these metals amounts to several years at temperatures below 400°C.

541.12 : 537.52

CHEMICAL REACTIONS IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. See Abstr. 10891

541.12

12103

IONIZATION IN SEEDED DETONATION WAVES.

S.Basu.

Phys. of Fluids, Vol. 3, No. 3, 456-63 (May-June, 1960).

Reports an investigation of equimolal oxyacetylene detonations at 1/10-atm initial pressure, which were seeded with potassium acetylide (C_2HK) to obtain good electrical conductivity. Finely ground (10-μmean diam) potassium acetylide was injected into the initial mixture and the density of the resulting aerosol was determined by a sedimentation technique. The electrical conductivity was determined by a magnetohydrodynamic interaction method developed by Lin (see Abstr. 2830 of 1955). The measured conductivities were compared with the results of thermodynamic equilibrium calculations, which included the cooling effect due to the heat capacity of the additive. Predicted and measured conductivities have approximately the same dependence on the mole fraction of potassium which was varied from 0.1 to 10%. At the temperatures of interest (3500-4000°K) reported values of electron-gas (CO, H, and H_2) and electron-potassium collision cross-sections are about 10^{-15} cm^2 and 40 × 10^{-15} cm^2, respectively. With these values, the theoretical and measured electrical conductivities agreed within a factor of two, the agreement proving with increasing mole fraction of potassium. An electron-gas cross-section of 2.5 × 10^{-15} cm^2 gave good agreement between theory and experiment. The maximum measured conductivity was 2.7 mho/cm and occurred at about 3% potassium in the product gases. Ionization was essentially complete within about 40 μsec behind the wave front.

541.12

12104

[WAVE] STRUCTURE OF GASEOUS DETONATION IN PIPES.

Yu.N.Denisov and Ya.K.Troshin.

Zh. tekh. Fiz., Vol. 30, No. 4, 450-9 (April, 1960). In Russian.

Results are described of photographic investigations. The photographs show, in the absence of plane leading wave-fronts, the important role of front fractures in the propagation of chemical reactions. Detonations were either continuous or pulsating. Pulsating detonation is associated with a periodic propagation of the chemical reaction. Continuous detonation is merely a special case of the pulsating one, when the fracture of the wave-front indicates a localization of the chemical reaction. Some qualitative relations between the parameters of the detonation wave, the initial conditions of the medium and the gas velocity are quoted.

J.K.Skwirzynski

541.12 : 534.22

12105

THE INTERACTION OF WEAK SHOCK WAVES WITH A FLAME FRONT.

G.D.Salamandra and I.K.Sevast'yanova.

Zh. tekh. Fiz., Vol. 29, No. 11, 1360-7 (Nov., 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 11, 1250-7 (May, 1960).

A transition from slow burning to detonation occurs when a shock wave interacts with the flame front or the flame travels through a region previously disturbed by a shock. The shock wave may be formed in the initial stage of flame propagation or in the predetonation stage. The distance in which the transition occurs has been measured in various mixtures of hydrogen, methane, or acetylene, with oxygen, over a range of pressures. E.R.Wooding

541.12 : 536.55

TEMPERATURE MEASUREMENT OF THE FRONT OF DETONATION OF EXPLOSIVES. See Abstr. 10814

ELECTROCHEMISTRY

541.13

12106

THE ISOTOPIC EXCHANGE OF HYDROGEN ON PALLADIUM.

G.N.Trusov and N.A.Aladzhalova.

Dokl. Akad. Nauk SSSR, Vol. 130, No. 2, 370-3 (Jan. 11, 1960). In Russian.

Using deuterium and tritium the rate of exchange of hydrogen between absorption layers on a palladium cathode and an electrolyte (D_2SO_4 and KOD) was measured. The results are shown graphically and it is demonstrated that the increase in velocity of isotopic exchange with applied potential difference cannot be linked with the increase in activity of hydrogen on the exchange surface because of saturation effects. H.C.Cole

541.13

12107

INDUCED E.M.F. IN ELECTROLYTES.

F.Heinmets.

J. chem. Phys., Vol. 32, No. 4, 1264-5 (April, 1960).

The interaction between an induced electric field and ions in solution was studied in different electrolytes (HCl, NaCl, KCl, $CuSO_4$, H_2SO_4) at various concentrations. The results confirm that Maxwell's law of induction is valid in electrolytic media.

G.I.W.LLewelyn.

PHOTOCHEMISTRY
RADIATION CHEMISTRY

541.15

12108 ALPHA RADIOLYSIS OF CO WITH AND WITHOUT Xe.
P.S.Rudolph and S.C.Lind.
J. chem. Phys., Vol. 32, No. 5, 1572-3 (May, 1960).

CO with and without Xe was exposed to radon. The pressure change in the reaction vessel was the measure for the progress of the reaction, $3\,CO \rightsquigarrow CO_2$ + solids. The validity of this procedure was checked by cryogenic separation of the gases. The logarithm of CO pressure plotted versus the fraction of radon decayed gave parallel curves for both conditions. Xe therefore did not change the reaction rate. Charge transfer from CO^+ to Xe is known to occur and should result in a reduced reaction rate. A compensating mechanism of excitation transfer from Xe* to CO is postulated to account for the observed unchanged reaction rates. M.Ebert

541.15

12109 NUCLEAR RECOIL IN THE CRYSTALLINE HEXACHLOR-COMPLEX OF TETRAVALENT Ir.
W.Herr and K.Heine.
Z. Naturforsch., Vol. 15a, No. 4, 323-5 (April, 1960). In German.

The Szilard—Chalmers reaction in crystals of $Na_2IrCl_6 \cdot 6H_2O$, K_2IrCl_6, and $(NH_4)_2IrCl_6$ was investigated by paper electrophoresis. Several Ir^{192} recoil species could be separated, their number and relative abundance being different for the three salts, e.g. in neutron irradiated $Na_2IrCl_6 \cdot 6H_2O$ six recoil species could be distinguished. On heating the crystals to 123°C, the original substance is regenerated only by some of the fragments. The re-formation of the original compound (annealing) may be described by a first order reaction.

DISPERSIONS . COLLOIDS
ADSORPTION

541.18

12110 PHOTOELECTRIC MIST DROPLET MEASURER.
M.Deloncle.
C.R. Acad. Sci. (Paris), Vol. 250, No. 13, 2409-11 (March 28, 1960).
In French.

The performance is discussed of a scanning photoelectric microscopic instrument (with oscilloscopic output) for measuring the particle size of water droplets in mists and fogs. R.W.Nicholls

541.18

12111 DIFFUSION AND SEDIMENTATION OF MACROMOLECULAR CHAINS IN SOLVENT Θ.
S.Klenine, H.Benoit and M.Daune.
C.R. Acad. Sci. (Paris), Vol. 250, No. 19, 3174-6 (May 9, 1960).
In French.

For a solution of low-molecular-weight (5×10^4) polybutylmethacrylate in isopropyl alcohol, the coefficients of diffusion (D) and the sedimentation constant (S) are independent of concentration, whereas S increases with decreasing concentration at higher molecular weights (1.8 and 8.5×10^6). R.F.Barrow

541.18

12112 SEDIMENTATION OF THORIUM OXIDE SLURRIES AT ELEVATED TEMPERATURES.
S.A.Reed and P.R.Crowley.
Nuclear Sci. Engng, Vol. 1, No. 6, 511-21 (Dec., 1956).

Rates of sedimentation are reported for concentrated, flocculated aqueous suspensions of thorium oxide at temperatures from 150 to 325°C. Sedimentation tests were carried out in quartz tubes using a motion picture camera to follow sedimentation in the hindered settling region. The observed rates were used as a basis for calculating the effective particle diameters and densities of the sedimenting bodies at the elevated temperatures. The calculations are based on the premise that the slurries are agglomerated and that the nature of the agglomerates varies with temperature.

541.18

12113 ATTRACTION OF SMALL PARTICLES SUSPENDED IN A LIQUID AT LARGE DISTANCES. L.P.Pitaevskii.
Zh. eksper. teor. Fiz., Vol. 37, No. 2(8), 577-8 (Aug., 1959).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 37(10), No. 2, 408-9 (Feb., 1960).

Formulae are derived for the Van der Waals interaction energy between uncharged particles suspended in a liquid.
W.J.Orville-Thomas

541.18

12114 SURFACE PROPERTIES OF HIGHLY DISPERSED QUARTZ.
L.G.Ganichenko, M.M.Egorov, V.F.Kiselev, K.G.Krasil'nikov and G.S.Khodakov.
Dokl.Akad. Nauk SSSR, Vol. 131, No. 3, 597-600 (March 21, 1960).
In Russian.

Water vapour isotherms are given for quartz milled to different degrees of fineness. The results are supplemented by data based on differential thermal analyses. The specific surface, particle diameter, degree of surface hydration, content of amorphous phase, thickness of amorphous layer and irreversible sorption are tabulated. The results are discussed in relation to the nature of the surface and the mechanism of adsorption. R.F.S.Hearmon

541.18

12115 ADSORPTION ON CLEAN GERMANIUM SURFACES.
M.Green and K.H.Maxwell.
J. Phys. Chem. Solids, Vol. 11, No. 3-4, 195-204 (Oct., 1959).

The adsorption of various gases on clean germanium surfaces has been investigated. At room temperature and for $(p/p_S) <\sim 5 \times 10^{-3}$, the gases found to adsorbed were H_2O, CH_3OH, $(CH_3)_2O$, CH_3COOH, $(CH_3)_2CHCH_2NH_2$, C_5H_5N, and p-dioxan, while H_2, N_2, CO, CO_2, CH_4, C_2H_4, CCl_4, $CHCl_3$, $(C_2H_5)_2O$, C_6H_6 and C_6H_5Cl were found not to be adsorbed within the limits of our experimental error. For those gases that were adsorbed, the adsorption was extremely rapid, and the extent of take-up was equivalent to about a monolayer coverage. The various classes of adsorbent-adsorbate binding forces have been examined with a view to identifying the type of binding force predominant in the adsorption. For H_2O, CH_3OH, $(CH_3)_2O$ in its enolic modification, CH_3COOH, and $(CH_3)_3CNH_2$, electrostatic interaction between the permanent charge distributions of the adsorbent was found to account for adsorption; the nature of the binding for these systems can be described as a form of "hydrogen bond". The adsorption of pyridine and p-dioxan cannot readily be explained on the basis of a simple classical electrostatic interaction picture. The non-adsorption of the gases listed above is shown to be expected if only classical electrostatic interaction is considered. However, it is not suggested that this electrostatic criterion is by itself the only criterion for non-adsorption.

541.18

12116 THE ADSORPTION OF OXYGEN ON CLEAN SILICON SURFACES. M.Green and K.H.Maxwell.
J. Phys. Chem. Solids, Vol. 13, No. 1-2. 145-50 (May, 1960).

The adsorption of oxygen on clean silicon surfaces produced by crushing in vacuo has been examined in the pressure range 30-200 μ Hg of oxygen at room temperature. The initial adsorption to the extent of about a monolayer was very rapid but kinetic data were obtained for the subsequent slow adsorption. The results were complex and probably sensitive to the crystal faces exposed during crushing. The adsorption process was found at an oxygen take-up equivalent to about 1.5 oxygen atoms per surface silicon atom. A unique configuration, with an inherent termination at a coverage of 1.5, can be constructed for oxygen adsorbed on the $\{111\}$ and $\{110\}$ faces of silicon. Prolonged crushing of the silicon led to an enhanced take-up of oxygen which may result from the heating of very small particles during the fast adsorption stage. The surface areas of the powders were determined by the B.E.T. method, using krypton at liquid nitrogen temperature.

541.18

12117 ABSORPTION OF HYDROGEN BY PALLADIUM SILVER ALLOYS. F.A.Lewis and W.H.Schurter.
Naturwissenschaften, Vol. 47, No. 8, 177-8 (1960).

The course of the absorption of hydrogen at 25°C from hydrogen saturated HCl solutions by wires of Pd alloyed with 10, 20, 26, 40 and 50% Ag(by weight) respectively, is followed by measurement of the (positive) electrode potentials against Pt/H_2 and of the relative electrical resistances of the specimens. Time-invariant potential plateaux are observed (not pronounced for the 50% Ag alloy), which appear to be associated with ranges of hydrogen content over which there is coexistence of two phases analogous to the α and β phases of the Pd/H system. The plateau potential increases with addition of up to 26% Ag, and is in accord with previous data for desorption plateaux at 20° by Vert and Tverdovskii [Zhurnal Fizicheskoi Khimii, Vol. 28, 317 (1954)]. There is a related increase in the chemical potential for absorption of hydrogen over the plateau region and a decrease of the vapour pressure of the hydride. A decrease in H/Me (1 atm: 25°C) with increase in Ag content is in general accord with the results of Rosenhall (Abstr. 39 of 1935) and of Vert and Tverdovskii. H.H.Hodgson

541.18

12118 THE FREEZING OF WATER AND BENZENE IN POROUS VYCOR GLASS. C.Hodgson and R.McIntosh.
Canad. J. Chem., Vol. 38, No. 6, 958-71 (June, 1960).

Freezing has been detected in the adsorbed water and benzene of porous Vycor glass at temperatures below that at which the bulk phases freeze. The evidence presented by equilibrium pressure measurements and dimensional changes of the systems is considered in terms of theories of capillary condensation and freezing in cements and soil. Although not all the results can be explained, it is concluded that the freezing process is a gradual one for both adsorbate—adsorbent systems. The evidence further suggests that hysteresis is absent in isotherms if the solid phase has formed.

541.18

12119 DIFFUSION AND HETEROGENEOUS REACTION. II. CATALYTIC ACTIVITY OF SOLIDS FOR HYDROGEN-ATOM RECOMBINATION. B.J.Wood and H.Wise.
J. chem. Phys., Vol. 29, No. 6, 1416-17 (Dec., 1958).

For Pt I, see Abstr. 9173 of 1958.

541.18

12120 THE APPLICATION OF THE PULSE MASS-SPECTROMETER TO THE STUDY OF GAS EVOLUTION FROM METALS. Yu.I.Belyakov and E.I.Agishev.
Zh. tekh. Fiz., Vol. 29, No. 6, 796-98 (June, 1959). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 4, No. 6, 717-19 (Dec., 1959).

Strips of nickel which had been given different surface treatments were sealed into glass vessels of 75 cm^3 volume. These vessels were connected to the ion source of a nonmagnetic pulse mass-spectrometer. The gas evolved on heating the nickel specimens to 800-900°C consisted mainly of CO and CO_2. A little hydrogen was found, but the bulk of hydrogen was driven off during the prolonged preliminary heating of the vessels. Small amounts of gas with mass numbers 15, 18, 27, 29, 35, and 37 were also found. Ion peaks with mass numbers 48 and 64 (SO^+ and SO_2^+) were noted in the spectra of all the nickel samples bar those containing silicon. The method of surface treatment affected the rate of gas evolution. Thus, for example, the quantities of CO given off from electrolytic nickel after 15 min at 850°C were in the ratio 4 : 1 : 6 for strips etched with aqua regia, or with chromic acid, or for strips which had been electrolytically polished, respectively. The corresponding ratio for CO_2 evolution was 1 : 4 : 1. The CO evolution from electrolytic nickel at 800°C yielded a diffusion coefficient of 7.9×10^{-9} cm^2/sec for carbon monoxide in nickel at this temperature. R.Schnurmann

PHYSICAL METHODS OF CHEMICAL ANALYSIS

545

12121 PHOTO-ELECTRIC ABSORPTION OF SCATTERED GAMMA-RAYS.
M.M.Sokolov, A.P.Ochkur, A.A.Fedorov and N.I.Karabanov.
J. nuclear Energy, Vol. 9, No. 1-4, 182-3 (June, 1959). English translation from: Atomnaya Energiya, Vol. 4, 284 (1958).

Describes experiments made with a scintillation spectrometer (NaI:Tl) and Cr^{51} γ-rays to test a method of estimating heavy element impurities in a low-Z medium. Data are given for sand, either pure or containing lead or copper in known amounts (0.5 - 10%). J.D.Craggs

545

12122 INCREASING OF SENSITIVITY IN COPPER SPARK METHOD. E.Nauta and I.Perman.
"J. Stefan" Inst. Rep., Vol. 4, 151-6 (Oct., 1957).

By rotating the supporting electrode round its vertical axis with the ordinary spark-generator (15 kV, 250 W) detection limits were obtained equivalent to the values of Fred, Tomkins and Nachtrieb, (Abstr. 2311 of 1947) determined with the high-wattage generator. At the same time reproducibility increases because the nonuniformity of the evaporated film has little influence. A handy arrangement making the rotation possible has been constructed.

545.8

12123 SPECTROPHOTOMETRY OF THORIUM, WITH THORON, IN THE PRESENCE OF ZIRCONIUM.
E.Cerrai and F.Gazzarrini.
Energia nucleare, Vol. 7, No. 5, 358-60 (May, 1960). In Italian.

545 : 539.18

12124 MASS SPECTROMETRIC MEASUREMENTS OF UF_6. L.Debevec, V.Kramer, J.Marsel and V.Vrščaj.
"J. Stefan" Inst. Rep., Vol. 5, 33-9 (Oct., 1958).

At small differences in isotopic composition of two samples a very high reproducibility of the working conditions of the mass spectrometer is absolutely necessary. That can be achieved by alternating introduction of the samples being compared. The possibility of isotope fractionation in the gas inlet system and the influence of the "memory effect" on successive measurements was investigated. The isotope ratio 238/235 of natural uranium was determined as 138.2 ± 0.4.

GEOPHYSICS

550.3

12125 ZONAL HARMONICS OF THE EARTH'S GRAVITATIONAL FIELD AND THE BASIC HYPOTHESIS OF GEODESY.

J.A.O'Keefe.
J. geophys. Res., Vol. 64, No. 12, 2389-92 (Dec., 1959).

The basic hypothesis of geodesy as stated by Vening Meinesz and Heiskanen [The earth and its gravity field. New York: McGraw-Hill (1958)] calls for an extremely smooth gravitational field for the earth as a whole apart from local irregularities. From satellite measurements of zonal harmonics of orders 2, 3, and 4 it is shown that the actual roughness is about an order of magnitude greater than that demanded by the basic hypothesis of geodesy.

550.3

12126 WAVE PROPAGATION IN A MEDIUM WITH A SINGLE LAYER. L.Knopoff, F.Gilbert and W.L.Pilant.

J. geophys. Res., Vol. 65, No. 1, 265-78 (Jan., 1960).

The generation of Love waves by an impulsive source located in a medium with a single layer has already been studied. The fine structure of the dispersive Love wave train has been shown to correspond to the superposition of a number of multiple reflections within the surface layer. The propagation of P-SV motions in a layer can be represented in a similar way as the sum of contributions from an infinite set of images of the source taken in the two boundaries. A seismic model has been set up to demonstrate the features of the wave propagation. The train of Rayleigh waves is observed to lengthen as the epicentral distance increases. The other important events are the refracted P and S pulse groups; each of these lengthens with increase in epicentral distance. The duration and the envelopes of the refracted P and S events are features not heretofore anticipated. A theoretical investigation based on a quantitative ray theory verifies the existence of these events. The quantitative ray theory is a method by which a number of the problems arising in seismology can be treated without the usual involved mathematical operations. An experimental technique for directly determining the group velocity in a model layered structure is presented. The results of the seismic model agree with the theoretical values.

550.3

12127 ELASTIC MULTIPLET WAVES IN A MEDIUM CONSISTING OF HOMOGENEOUS, ISOTROPIC, PLANE PARALLEL LAYERS. F.Gassmann.

Mitt. Inst. Geophys., E.T.H. Zürich, No. 36, 3-27 (Aug., 1959).
In German.

This is a mathematical derivation of the elastic displacements of the waves that are reflected and refracted at the boundaries of the layers, having originated at a point source in the interior of one layer. The treatment is based on a method described by Cagniard in which, by the aid of Laplace transforms, certain exponential coefficients and transmission factors are calculated.

H.J.H.Starks

550.3

12128 THE WAVE-VELOCITY FUNCTION AND ITS INTERPRETATION IN THE REFRACTION SEISMIC OF A UNIAXIAL INHOMOGENEOUS MEDIUM. M.Weber.

Mitt. Inst. Geophys. E.T.H. Zürich, No. 36, 2-16 (Aug., 1959).
In German.

A mathematical treatment of the problem using hypergeometric functions.

H.J.H.Starks

550.3 : 534.2

A SIMPLIFIED METHOD FOR THE ANALYSIS AND SYNTHESIS OF DISPERSED WAVE TRAINS : EARTHQUAKE STUDIES.
See Abstr. 10714

550.3

12129 LONG EARTHQUAKE WAVES.
J. Oliver.

Sci. American, Vol. 200, No. 3, 131-3, 135, 137-8, 140, 142-3 (March, 1959).

A non-specialist description of the structure of the earth; the information to be gained from frequency—amplitude measurements of its oscillations during earthquakes; and the principles on which the various measuring devices operate.

550.3

12130 MEASURING THE THICKNESS OF GLACIERS BY ELECTROMAGNETIC METHODS.

V.N.Rudakov and V.V.Bogorodskii.
Zh. tekh. Fiz., Vol. 30, No. 1, 82-9 (Jan., 1960). In Russian.

Discusses the existing, and develops new, formulae for the relationship between the dielectric constant and the loss angle on the one hand and temperature and frequency of electromagnetic waves on the other, the theoretical and experimental foundations being mainly the formulae of Debye and the results of Eder [see Abstr. 1361 B of 1948; Ann Phys. (Leipzig), Vol. 1, No. 7-8, 381-98 (1947)]. The total decay of the signal, due to (1) the absorption of the electromagnetic field by ice, (2) scattering of that field by ice crystals, and (3) other causes (non-ideal transparency of the air-ice boundary, non-specular reflection from the ice-rock boundary etc.), should not exceed 100 dB (at λ = 1 m).

F.Lachman

550.3 : 621.391.8

12131 MEASURED ELECTRICAL PROPERTIES OF SNOW AND GLACIAL ICE. A.D.Watt and E.L.Maxwell.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 357-63 (July-Aug., 1960).

The electrical properties of snow and glacial ice near 0° C have been observed over the frequency range from 20 c/s to 200 kc/s. In general, the conductivity of snow and glacial ice is found to be much higher than that for pure ice. This is particularly so at frequencies below 2 kc/s. The magnitude of the complex conductivity for glacial ice appears to increase with temperature at frequencies below 200 c/s and to decrease with temperature above this frequency.

550.3

12132 STUDIES OF NATURAL ELECTRIC AND MAGNETIC FIELDS. G.D.Garland and T.F.Webster.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 405-8 (July-Aug., 1960).

Simultaneous measurements of short-period natural electric field variations across Western Canada are reported. From these it is indicated that the effect of the varying depth to the Precambrian rocks is the dominant factor. Analysis of the simultaneous, magnetic and electric measurements gives a resistivity for the Precambrian basement in excess of 30 × 10^5 ohm metres.

550.3

12133 A RADIAL ROCKET SURVEY OF THE DISTANT GEOMAGNETIC FIELD.

C.P.Sonett, D.L.Judge, A.R.Sims and J.M.Kelso.
J. geophys. Res , Vol. 65, No. 1, 55-68 (Jan., 1960).

A survey magnetometer carried aboard the Air Force Pioneer I space probe obtained data over the interval 3.7 to 7 and 12.3 to 14.8 geocentric radii. The day was unusually quiet magnetically ($A_p \sim 5$) with a long quiet prior history. The data indicate an invers cube-field decrease in the region of 3.7 to 13.6 radii, where termination takes place, with a subsequent decrease to 5 × 10^{-5} G. This value is examined in the light of possible interplanetary gas activity. The surprisingly distant geomagnetic cutoff suggests a very low gas pressure on the day of the flight. Increasingly large (fractionally) fluctuations were observed with increasing radii. A gross variabilit in the vestigial field would suggest hydromagnetic activity or a comp gas cloud structure.

550.3

12134 DAILY NORMALS OF THE INTERNATIONAL MAGNETI CHARACTER FIGURE, C_1. R.Shapiro and F.W.Ward, Jr

J. geophys. Res., Vol. 65, No. 1, 115-18 (Jan., 1960).

Daily normals (averages) of C_1 have been computed for each day of the year using the "final" C_1 figures for the 72-year period 1884-1955. The significance of departures of the daily averages fro a smoothed continuum is discussed. The observed departure can be attributed to random sampling fluctuations.

550.3

12135 OCCURRENCE FREQUENCY OF GEOMAGNETIC MICROPULSATIONS, Pc. J.A.Jacobs and K.Sinno.

J. geophys. Res., Vol. 65, No. 1, 107-14 (Jan., 1960).

An analysis of the occurrence frequency of geomagnetic micropulsations Pc has been carried out using data obtained during the I.G.Y. from a world-wide network of stations. From the characteristics of the diurnal occurrence frequency and their latitudinal and

longitudinal dependence, the following conclusions are drawn:
(1) The occurrence frequency of Pc's increases as the auroral zones are approached from lower latitudes. Also the hour of the diurnal maximum occurrence appears earlier at high-latitude stations.
(2) The occurrence frequency of Pc's depends not only on local time but also in part on universal time. The universal-time factor affects the modulation of the diurnal occurrence by about 50%. The time of maximum occurrence of Pc's is about 21 hours G.M.T. in the northern hemisphere. In the southern hemisphere the universal-time factor has opposite phase to that in the northern hemisphere. When the universal-time factor is a maximum in the northern (or southern) hemisphere, the north (or south) geomagnetic pole is about 16 or 17 hours L.M.T. The G.M.T. dependence derived in this investigation shows about 7 hours' difference compared with Troitskaya's conclusion (see Abstr. 4037 of 1954), which was based on data from several stations in the U.S.S.R.

550.3

12136 LUNAR DAILY VARIATION OF GEOMAGNETIC HORIZONTAL INTENSITY AT ALIBAG. K.S.Raja Rao.

J. geophys. Res., Vol. 65, No. 1, 119-22 (Jan., 1960).

Following the mathematical development of Chapman and Miller (1940), Tschu (1949) has described a practical method of determining the lunar daily variation of geophysical elements. The lunar semi-diurnal variation of geomagnetic horizontal intensity at Alibag has been worked out for the equinoctial season by making use of the hourly values of the element for the period 1940 to 1944. The expression $L(H) = 1.2 \sin(2\tau + 62^{\circ}) \pm 0.3$ where L(H) is the amplitude of the lunar variation in the horizontal intensity H and τ is the lunar time reckoned from lower transit of mean moon at Alibag is obtained for lunar semi-diurnal variation. L(H) is a maximum when the lunar time is 2 lunar hours past midnight or noon. The solar diurnal variation is also determined up to 4 harmonics. A comparison of these results with similar results for Kodaikanal suggests that solar and lunar variations are independent of each other.

550.3

12137 MOTION OF GEOMAGNETIC FIELD LINES. C.J.Loughnan.

Nature (London), Vol. 186, 33-4 (April 2, 1960).

It is shown that possible horizontal displacement of lines of geomagnetic force (which are followed by primary auroral particles) is strongly limited by the relatively high conductivity of the earth's interior to values between 20 and 50 km at a height of 1000 km. Observations on the radiation points of auroral coronae confirm this deduction. R.W.Nicholls

550.3

12138 HYDROMAGNETIC THEORY OF GEOMAGNETIC STORMS. A.J.Dessler and E.N.Parker.

J. geophys. Res., Vol. 64, No. 12, 2239-52 (Dec., 1959).

A hydromagnetic theory is presented which explains the average characteristics of geomagnetic storms. The magnetic storm is caused by a sudden increase in the intensity of the solar wind. Stresses are then set up in the geomagnetic field by the solar plasma impinging upon the geomagnetic field and becoming trapped in it. These stresses, which are propagated to the earth as hydromagnetic waves, account for the observed average magnetic storm variations. The sudden commencement of the magnetic storm is due to a hydromagnetic wave generated by the impact of the solar plasma on the geomagnetic field. The initial phase of the magnetic storm, during which the magnetic field is above average intensity, is due to the increased solar wind pressure. During the initial phase, instability causes small plasma clouds to become imbedded in the magnetic field. They break up and diffuse into the magnetic field to form a belt of trapped particles from the sun (principally protons and electrons). The trapped protons set up stresses, mainly due to centrifugal force, which account for the main phase of the magnetic storm. The recovery from the main phase is attributed to the relief of the stress on the geomagnetic field by the transfer of the energy of the trapped protons to neutral hydrogen by means of ion-atom charge exchange. The correct recovery time for the magnetic storm is predicted from the measured cross section of the ion-atom charge-exchange process and the hydrogen density values around the earth deduced from the scattering of solar Lyman-α radiation.

550.3

12139 THE SIMULTANEITY OF SUDDEN COMMENCEMENTS OF MAGNETIC STORMS. V.L.Williams.

J. geophys. Res., Vol. 65, No. 1, 85-92 (Jan., 1960).

Rapid-run magnetograms from the U.S. Coast and Geodetic Survey and from other observatories located near the magnetic equator were used to study sudden commencements that occurred during the period October 1957 to September 1958. Analysis of these magnetograms yielded three important results: (1) the sudden commencement always occurred first in high or middle latitudes; (2) Little America, Antarctica, registered the sudden commencement first or second 85% of the time; and (3) the apparent propagation velocities of the sudden commencement around the magnetic equator had average values between 1145 and 2835 km/sec.

550.3

12140 GEOMAGNETIC STORM THEORY. J.H.Piddington.

J. geophys. Res., Vol. 65, No. 1, 93-106 (Jan., 1960).

A discussion of the two-gas theory of the transmission of geomagnetic disturbances through the atmosphere (to several earth radii) is extended, with the following results: (1) the central problem concerning the main phase of a geomagnetic storm is the mechanism of penetration of solar ions into the geomagnetic field. An explanation is given depending on a combination of a uniform electric space-charge field and a system of irregular fields; (2) a model of the main phase of a geomagnetic storm is given, the principal feature of which is a "magnetic tail" extending from the earth on the dark side; (3) the model may help to explain some other effects: the Gegenschein, electrons with auroral energies, the location of the Van Allen zones, and diurnal cosmic-ray variations; (4) all observed geomagnetic disturbances have their sources initially in current systems in the lower ionosphere. Some are subsequently maintained by current systems in the earth itself and in the region of interaction between the solar and terrestrial plasmas. Others, mainly polar and equatorial, are maintained by ionospheric currents driven by space-charge electric fields; (5) any ring current outside the geomagnetic field could cause an increase in the horizontal component. A westward-flowing ring current embedded in the field could cause either an increase or a decrease in the horizontal component. The basic effect is not the current but a sustained inward or outward mechanical force on the material in which the current flows.

550.3 : 551.5

CORRELATION OF OCCURRENCE OF WHISTLERS WITH GEOMAGNETIC ACTIVITIES. See Abstr. 12209

550.3

12141 GEOMAGNETIC DISTURBANCES DUE TO NUCLEAR EXPLOSION. H.Maeda.

J. geophys. Res., Vol. 64, No. 7, 863-4 (July, 1959).

Geomagnetic data collected at the I.G.Y. World Data Centre C2 for geomagnetism, Kyoto University, show that while no displacement is observed on magnetograms as a result of ground-level nuclear explosions, there is nevertheless strong correlation between the times of marked magnetogram displacements on Aug. 1 and 12, 1958, and the times of known high-altitude nuclear explosions. R.W.Nicholls

550.3

12142 GEOMAGNETIC EFFECTS OF HIGH-ALTITUDE NUCLEAR EXPLOSIONS. A.G.McNish.

J. geophys. Res., Vol. 64, No. 12, 2253-65 (Dec., 1959).

Two high-altitude nuclear explosions detonated near Johnston Island in August 1958 produced distinct geomagnetic effects at Honolulu, Palmyra Island, Fanning Island, Jarvis Island, and Apia. No other operating magnetic observatories reported discernible effects. The effects at the first four observatories are attributed to overhead currents caused by increased ionization of the atmosphere by γ-rays and their secondaries from the detonations. The effects at Apia are attributed to charged particles from the detonations and Compton electrons released from the air around the detonation.

550.3 : 539.17

12143 POSSIBILITY OF A MAGNETIC EFFECT OF HIGH-ALTITUDE EXPLOSIONS OF ATOM BOMBS.

O.I.Leipunskii.

Zh. eksper. teor. Fiz., Vol. 83, No. 1, 302-4 (Jan., 1960). In Russian.

A dense gas plasma, likely to form at such explosions, will spread at a rate of several hundred km/sec until its kinetic pressure equals the magnetic pressure. Owing to the diamagnetic nature of the plasma, the magnetic field of the earth will be weakened or annihilated inside the plasma, which is equivalent to the formation of a dipole within the plasma, whose field is opposed to that of the earth. The generation of this dipole would be detectable at a large distance in the form of a magnetic disturbance (storm); increased magnetic disturbances are expected at the epicentres of conjugated points or of trap ends. It is calculated (under certain assumptions) that the time of increase of the front of the magnetic disturbance for the "Argus" explosion should be about 0.5 sec. According to Newman (see Abstr. 10431 of 1960), and Selzer [C.R. Acad. Sci. (Paris), Vol. 249, No. 13, 1133-5, Sept. 28 (1959)], periodic magnetic disturbances with a period of 1-2 sec were observed during the "Argus" explosion. F.Lachman

550.9

12144 MASS SPECTROMETRIC INVESTIGATIONS ON LEAD MINERALS.

H.Ehrenberg and H.J.Mürtz.

ForschBer. Landes Nordrhein-Westfalen, No. 696, 31 pp. (1959). In German.

The determination of the age of the earth depends on accurate measurements of the concentration of the lead isotopes Pb^{206}, Pb^{207} and Pb^{208} in lead bearing minerals. Comparison of mass spectrometric data obtained at Berne, Bonn, and Toronto showed the need of evaluating the experimental results by the same method, and also the desirability of working without a deflecting magnet for the electrons from the source of the mass spectrometer. If this magnet were not omitted, the ions would also be slightly deflected, particularly in the region where they are accelerated, so that the isotope ratio would appear falsified. R.Schnurmann

ATMOSPHERE . IONOSPHERE

(Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

551.5 : 523.4

OUTER ATMOSPHERES OF MARS AND VENUS: COMPARISON WITH THAT OF THE EARTH. See Abstr. 10494

551.5

12145 POWER-SPECTRUM ANALYSIS OF ATMOSPHERIC OZONE PARAMETERS.

A.Adel and E.S.Epstein.

J. Meteorol., Vol. 16, No. 5, 548-55 (Oct., 1959).

Power spectra have been computed for three parameters of atmospheric ozone: ERTOR (effective radiation temperature of the ozone region), absorption of solar radiation by ozone in the 9.6 micron band, and total amount of ozone as measured with a Dobson spectrophotometer. Power spectra have been computed also for 700 mb middle-latitude zonal wind, geomagnetic planetary index, and Farthing's "net" index of solar coronal activity. All the spectra of the atmospheric variables exhibit spectral peaks in the vicinity of two and one-half week periods. Additional peaks in several of the ozone spectra suggest a high atmospheric level summertime variation in ozone densities with a period near one and one-half weeks.

551.5

12146 MEASUREMENT OF IONOSPHERIC ELECTRON DENSITIES USING AN RF PROBE TECHNIQUE.

J.E.Jackson and J.A.Kane.

J. geophys. Res., Vol. 64, No. 8, 1074-5 (Aug., 1959).

Measurements of the capacitative reactance at 7.75 Mc/s of the rocket-borne transmitting aerial, as a by-product in the ionosphere rocket radio-propagation experiments, show that above 110 km the variations can be directly related to the electron density. When a constant correction factor is applied (believed to be due to a positive-ion sheath around the rocket), the electron density profile obtained by the propagation data and the probe data are found to be in very good agreement. G.M.Brown

551.5

12147 ANNUAL VARIATION OF MEAN ELECTRON CONCENTRATION BETWEEN 400 AND 1200 km.

L.Klinker, K.H.Schmelovsky and R.Knuth.

Naturwissenschaften, Vol. 47, No. 9, 197-8 (1960). In German.

Measurements during 1958-9 on the Faraday fading of satellite signals at 20 Mc/s have enabled a mean curve for summer and winter to be drawn. Some indication of diurnal variation is also given. J.M.Hough

551.5

12148 SOME CHARACTERISTICS OF THE UPPER-AIR MAGNETIC FIELD AND IONOSPHERIC CURRENTS.

A.J.Zmuda.

J. geophys. Res., Vol. 65, No. 1, 69-84 (Jan., 1960).

Characteristics of the upper-air magnetic field and ionospheric currents are determined through an analysis of published rocket dat on the magnetic scalar intensity. For the region between the earth's surface and the E layer of the ionosphere, the observed values are compared with values obtained by extrapolating the surface vector field. The agreement between the two sets of values is very good fo equatorial flights but only fair for a flight at White Sands, New Mexi The equatorial, ionospheric current density, which has a maximum of about 21 A/km^2, varies considerably with time and location of the rocket flight. The equatorial electrojet has a current intensity of about 130 A/km and flows practically along the magnetic equator. Some of the computed currents associated with the normal magnetic daily variation are at variance with those expected from considerations, such as harmonic analysis, of the surface transient field and sheet-current approximations. In the area around White Sands (geomagnetic latitude 41°N) a large negative magnetic anomaly exists that may contribute to the formation of the region of low intensity of radiation that lies between the two Van Allen radiation belts.

551.5 : 525

12149 PROFILE OF UPPER-ATMOSPHERE AIR DENSITY AT THE HEIGHT 180-212 km. DERIVED FROM THE ORBIT OF SPUTNIK III.

Z.V.Bochníček.

Nature (London), Vol. 186, 460-1 (May 7, 1960).

From the analysis of the data of the orbital elements of Sputnik III the value of the scale height (H_1) in the case of an isothermal atmosphere, and the ratio $(H_1/H_2)^2$, where H_2 is a constant which enables account to be taken of the variation of atmospheric temperature with height, are computed. It is found tha $H_1 = 46.3 \pm 0.7$ km. and $(H_1/H_2)^2 = 0.024 \pm 0.006$. These values agree well with those obtained by Groves, (Abstr. 10407of 1960). C.F.Barnaby

551.5 : 525

12150 MEASUREMENT OF SOLAR AND DIURNAL EFFECTS IN THE HIGH ATMOSPHERE BY ARTIFICIAL SATELLITES.

H.A.Martin and W.Priester.

Nature (London), Vol. 185, 600-1 (Feb. 27, 1960).

On the basis of a linear relationship, already established, between atmospheric density and 20 cm solar radiation, density data for satellite 1958β2 have been reduced to a standard value of the solar flux, so that solar and terrestrial effects can be studied. The density is a maximum over the equator, and shows a marked diurnal variation with a maximum about 25° after noon. These fluctuations imply a daily vertical movement of the atmosphere. G.M.Brown

551.5

12151 THE THERMOSPHERE.

M.Nicolet.

Ann. Geophys., Vol. 15, No. 1, 1-22 (Jan.-March, 1959). In French.

It can be deduced from recent rocket experiments that the temperature of the mesopause is of the order of 150 ± 20°K, and that the temperature of the lowest thermosphere in which the green line of atomic O is emitted is very low. It is wrong to use a constant O/N ratio right from the lowermost layer of the thermosphere; moreover, the number of O_2 molecules is not related to that of O atoms. The applicability of Mange's general criterion of diffusion is discussed, as well as the temperature distribution in the thermosphere and the problem of dissociation of molecular nitrogen. F.Lachman

551.5

12152 CONSTITUTION OF THE ATMOSPHERE AT IONOSPHERIC LEVELS.

M.Nicolet.

J. geophys. Res., Vol. 64, No. 12, 2092-101 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). A physical picture of the upper atmosphere cannot be obtained without determining whether vertical distribution depends on mixing or diffusion or on a chemical of photochemical equilibrium. It is necessary to determine how dissociation and recombination of molecular and atomic oxygen and nitrogen are distributed with height. The structure of the atmosphere deduced from density measurements is related to the variation of the mean molecular mass depending on diffusion effects. In addition, it is necessary to know how the heat budget is affected by conduction.

551.5

12153 **DYNAMICS OF THE UPPER ATMOSPHERE. P.A.Sheppard.**

J. geophys. Res., Vol. 64, No. 12, 2116-21 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The mean temperature and motional structure of the stratosphere, mesosphere, and lower ionosphere are described, and the thermodynamics of these regions is considered briefly. Possible disturbances on the mean motion are discussed. It is concluded that vertical convection is a very unlikely cause of such disturbances, that slantwise convection undoubtedly will release potential energy, thus supporting such disturbances, and that small-scale turbulence, though not likely generally, will probably be produced locally (in time and space) in the vicinity of jets in the large-scale baroclinic disturbances.

551.5 : 532.5

12154 **THE MOTION OF FLUIDS WITH DENSITY STRATIFICATION. R.R.Long.**

J. geophys. Res., Vol. 64, No. 12, 2151-63 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The mathematical complications of the theory of fluids with density stratification in a gravity field stem from the generation of vorticity in such fluid systems. Even if the fluid starts from rest and can be considered frictionless, anything but the most trivial subsequent motion is rotational. Then the solution of the problem involves solution of the Navier—Stokes equations. In one particular but important case these equations can be integrated once to yield a second-order partial differential equation in the stream function, but even here the governing equation is nonlinear. It is tractable, however, in some interesting cases. A few of them are discussed and compared with experiment. Under many circumstances flow of a stratified fluid is characterized by the presence of strong velocity concentrations or jets. This phenomenon as observed in the laboratory and in atmosphere and oceans is discussed. The problem is approachable theoretically by means of boundary-layer theory. This approach is current research, and only a few results can be given.

551.5

12155 **ELECTRODYNAMIC STABILITY OF A VERTICALLY DRIFTING IONOSPHERIC LAYER. J.A.Fejer.**

J. geophys. Res., Vol. 64, No. 12, 2217-18 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The electrodynamic stability of a vertically drifting ionospheric layer is examined under certain simplifying assumptions. No evidence of instability is found.

551.5

12156 **ATMOSPHERIC TIDES AND IONOSPHERIC ELECTRODYNAMICS. M.L.White.**

J. geophys. Res., Vol. 65, No. 1, 153-71 (Jan., 1960).

A brief review is given of the resonance theory of atmospheric tidal oscillations including both thermal and gravitational excitation. Semiempirical wind patterns for various latitudes are given, and also the semiempirical variation of solar semidiurnal wind velocities with height base on (1) solar barometric variations at ground level (Chapman, 1951); (2) wind measurements at balloon heights (Johnson, 1955); (3) radio meteor echo experiments (Greenhow and Neufeld, 1955); (4) E-region winds from radio pulse techniques (Briggs and Spencer, 1954); and (5) airglow cell movements (Roach et al, 1958). Finally, current work on the extension of modern tidal theory (valid for a neutral envelope) into the dynamo region is discussed (White, 1960).

551.5

12157 **AN INTERPRETATION OF CERTAIN IONOSPHERIC MOTIONS IN TERMS OF ATMOSPHERIC WAVES. C.O.Hines.**

J. geophys. Res., Vol. 64, No. 12, 2210-11 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Internal atmospheric waves, subject to gravitational and compressional forces, have characteristics in close accord with measurements of ionospheric motions revealed by meteor trails. They are also consistent with other types of observational evidence on movement in the ionosphere. Many of the observations may therefore find their proper interpretation in terms of these waves.

551.5 : 538.3

12158 **MAGNETOHYDRODYNAMIC WAVE PROPAGATION IN THE IONOSPHERE. S.L.Kahalas.**

Phys. of Fluids, Vol. 3, No. 3, 372-8 (May-June, 1960).

The propagation of magnetohydrodynamic waves in a compressible fluid is discussed with reference to the ionosphere. An investigation of the damping for a gas of finite conductivity shows that different wave modes may be heavily attenuated in certain directions of propagation. Also, the slow wave of the magneto-acoustic mode is shown to exhibit preferentially less damping for propagation along the magnetic field lines. An examination of the Hall and electron pressure terms shows that they may be neglected for low enough wave frequencies. The coupling of electromagnetic to magnetohydrodynamic waves at a plasma-vacuum boundary is considered. The coupling coefficient is estimated to be one percent.

551.5

12159 **AIR MOTIONS AT METEORIC HEIGHTS. L.A.Manning.**

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 137-40 (1959).

Results are given of a new method of analysing detailed wind movements at altitudes between 80 and 110 km based on measurements of the strength, and rate of fading of radio signals reflected off wind-distorted meteor trails. The wind at these heights is predominantly horizontal, with individual velocities of 50-70 m/sec, the mean drift velocity being 30 m/sec. The average vertical velocity is found to be no more than a few metres per second, and the mean gradient (with altitude) is 100 m/sec per km. The results are quite consistent with Whipple's data derived from meteor photography.

D.R.Barber

551.5

12160 **UPPER-AIR DENSITY AND TEMPERATURE: SOME VARIATIONS AND AN ABRUPT WARMING IN THE MESOSPHERE.**

L.M.Jones, J.W.Peterson, E.J.Schaefer and H.F.Schulte.

J. geophys. Res., Vol. 64, No. 12, 2331-40 (Dec., 1959).

Measurements of upper-air densities and temperatures from 12 flights of the rocket-borne falling sphere are presented. They show little seasonal variation at 32° and 38°N, but large variations in a few winter days at 59°N. A low arctic density at 60 km results in a linear latitude density gradient of about 2% per degree of latitude. Such a gradient was measured in a latitude survey. An abrupt warming at 45 km was detected at Fort Churchill in January 1958 and related to a warming of larger scope detected by balloons. The average air temperatures above Fort Churchill from January to March are warmer at 75 km and cooler from 50 to 30 km than at 32° to 38°N.

551.5

12161 **IONIZATIONS AND DRIFTS IN THE IONOSPHERE. J.A.Ratcliffe.**

J. geophys. Res., Vol. 64, No. 12, 2102-11 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Knowledge of the vertical distribution, and the horizontal irregularities and movements, of electrons in the ionosphere is summarized. The mechanism by which electrons can be moved either by the movement of the surrounding air or by electric fields arising from charges elsewhere in the ionosphere is discussed. The statistical description of a randomly moving distribution function which is commonly used by investigators of the ionosphere is described.

551.5

12162 **LARGE-SCALE MOVEMENTS OF IONIZATION IN THE IONOSPHERE. D.F.Martyn.**

J. geophys. Res., Vol. 64, No. 12, 2178-9 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The complexity of the causes of variations in and motions of ionization in the ionosphere is noted, as is the difficulty of differentiating real and virtual motions. An instability mechanism for deviations in ionization density is suggested, for which the predicted temporal and spatial morphologies appear to be consistent with those of the occurrence of sporadic E, spread F, and radio-star scintillations.

551.5

12163 **EVIDENCE OF ELONGATED IRREGULARITIES IN THE IONOSPHERE. B.Nichols.**

J. geophys. Res., Vol. 64, No. 12, 2200-2 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Radio observations of backscatter from ionospheric irregularities under both auroral and nonauroral conditions indicate the presence of small-scale irregularities, elongated along the earth's magnetic field. These elongated irregularities have been found at heights from 80 to 300 km. The most precise measurements available are related to echoes from auroral ionization at a height of about 100 km. These indicate scales of tens of meters along the earth's magnetic field and tens of centimeters normal to the field.

551.5

12164 EDDY DIFFUSION AND ITS EFFECT ON METEOR TRAILS. J.S.Greenhow.

J. geophys. Res., Vol. 64, No. 12, 2208-9 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Information about the small-scale turbulence at heights near 90 km has been obtained from photographic meteor trails. The time constant of the smallest eddies is found to be approximately 30 sec, and the turbulence power to be 70 ergs g^{-1} sec^{-1}.

551.5

12165 TRAVELING DISTURBANCES ORIGINATING IN THE OUTER IONOSPHERE. K.Bibl and K.Rawer.

J. geophys. Res., Vol. 64, No. 12, 2232-8 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Some observations that have been obtained with variations of the classical echo-sounding method must be interpreted as resulting from perturbation and/or oscillation phenomena occurring in the outer ionosphere. The vertical velocity component of "travelling disturbances" coming from outside and propagating through the ionosphere is determined as 115 ± 35 m/sec. Oscillation-like phenomena have a large range of quasi-periods, between 1/4 and 12 hours.

551.5

12166 POLAR AURORAL, GEOMAGNETIC, AND IONOSPHERIC DISTURBANCES. E.H.Vestine.

J. geophys. Res., Vol. 65, No. 1, 360-2 (Jan., 1960).

Explanations of the increased frequency and intensity of aurorae near midnight, of the polar electrojets associated with polar magnetic disturbances and radio blackouts, and of the tendency of magnetic bays to recur near the same universal hour of time for several consecutive nights, are given in terms of the invariant

$$\int_{m_N}^{m_S} \sqrt{1 - F/F_m}\; dl$$

of particle motion (Rosenbluth and Longmire, Abstr. 8727 of 1957). F is the geomagnetic field strength and m denotes conditions at the "mirror" points. D.M.Gilbey

551.5 : 532.5

12167 THE NATURAL OCCURRENCE OF TURBULENCE. R.W.Stewart.

J. geophys. Res., Vol. 64, No. 12, 2112-15 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). In order to make the scientific meaning of the word "turbulence" clear, it is proposed that a fluid be called turbulent if each component of the vorticity is distributed irregularly and aperiodically in time and space, if the flow is characterized by a transfer of energy from larger to smaller scales of motion, and if the mean separation of neighbouring fluid particles tends to increase with time. Whether or not a flow is turbulent is not simply a matter of Reynolds number, since the stability of the flow is a criterion of at least equal importance. From the results of experimental work in recent years of a number of authors (Anderson, Frenkiel and Katz, Kellogg, Liller and Whipple, Malkus), it seems reasonable to infer that, with the exception of strong inversion layers, the atmosphere may be assumed to be turbulent everywhere, although the intensity of the turbulence varies widely in both time and space. If the Kolmogoroff similarity theory of locally isotropic turbulence is accepted, the most important parameter in the turbulent field is the energy dissipation ϵ.

551.5

12168 OUTLINE OF SOME TOPICS IN HOMOGENEOUS TURBULENT FLOW. S.Corrsin.

J. geophys. Res., Vol. 64, No. 12, 2134-50 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Following general remarks on the homogeneous turbulence problem, and an indication of kinematic and dynamic relations in the isotropic case, outlines are given of the phenomena of spectral transfer and tendencies toward isotropy. A discussion of Reynolds numbers is followed by detailed comparison of some characteristic lengths. There are, finally, an outline of so theories on spectral turbulent energy transfer and a mention of static pressure fluctuations.

551.

12169 EFFECT OF A MAGNETIC FIELD ON TURBULENCE I AN IONIZED GAS. J.W.Dungey.

J. geophys. Res., Vol. 64, No. 12, 2188-9 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The problem is formulated using the equations of motion for each constituent of the gas. Approximatio are discussed, and idealizations are adopted appropriate to the ionosphere. A physical picture is given for the generation of irreg larities in electron density by shear flow in the neutral air. Given the motion of the air, the electron density can be calculated, and this calculation is carried out in the linear approximation for an arbitrary Fourier component.

551.

12170 ON THE SIMILARITY OF TURBULENCE IN THE PRESENCE OF A MEAN VERTICAL TEMPERATURE GRADIENT. A.S.Monin.

J. geophys. Res., Vol. 64, No. 12, 2196-7 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The frequency spectrum of vertical turbulence components is considered in the case of a vertical temperature gradient. Similarity methods are employed, one to descri the energy and inertia ranges, another (Kolmogoroff) to describe the inertia and dissipation ranges. It is proposed that, since both theories hold in the inertia range, a relation can be determined between the two unknown universal functions involved.

551.

12171 ON THE SPECTRUM OF ELECTRON DENSITY PRODUCED BY TURBULENCE IN THE IONOSPHERE IN THE PRESENCE OF A MAGNETIC FIELD. I.D.Howells.

J. geophys. Res., Vol. 64, No. 12, 2198-9 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Starting from Dungey's results, approximate equations for number density of ionization are obtained, under the action of turbulence, diffusion, and a magnetic field, in various limiting cases. The principal result is that this mechanism cannot be expected to produce irregularities that are strongly elongated along the magnetic field. A form is obtained for the spectrum funct of number density below 140 km.

551.

12172 ON THE INFLUENCE OF THE MAGNETIC FIELD ON THE CHARACTER OF TURBULENCE IN THE IONOSPHERE. G.S.Golitsyn.

J. geophys. Res., Vol. 64, No. 12, 2212-14 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Based on the equations of magnetohydrodynamics. The estimates given show that its influence in the lower ionosphere up to heights of 150 to 200 km can be neglected. At heights greater than 200 km the influence of the earth's magneti field must be considered in the dynamics of the medium. The fact that the gases are highly rarefied constitutes an additional problem in formulating a theory of turbulence for the upper regions of the ionosphere. It is shown here that the ratio of Kolmogoroff's inner scale of turbulence to the mean free path of neutral molecules decreases with the decrease in number of particles n as $n^{1/4}$, reaching the value of the order 30 or less at the height of 250 km. Therefore, the theory of turbulent motions at such heights should not entirely neglect the molecular structure of the medium.

551.

12173 TURBULENT SPECTRA IN A STABLY STRATIFIED ATMOSPHERE. R.Bolgiano, Jr.

J. geophys. Res., Vol. 64, No. 12, 2226-9 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). After noting the discrepancy between the predictions of turbulence theory and the empirical evidence from radio experiments, it is suggested that this may be the result of modification of the turbulent spectra by the effects of buoyancy stably stratified layers. It is pointed out that in such situations netic energy of turbulence is converted, over a wide range of ales, to potential energy of the resulting density deviations, that is potential energy is subsequently destroyed by the action of rther turbulent mixing and molecular diffusion, and, finally, that e primary effect is to reduce the viscous dissipation rate gnificantly below that which normally would be estimated on the sis of large-scale turbulent motions. Universal forms are edicted for the kinetic energy and density fluctuation spectra, d in the buoyancy subrange (the part of the equilibrium range at reflects the anisotropy induced by the density gradient) the ergy spectrum is found to be proportional to $k^{-11/5}$, the density ectrum to $k^{-7/5}$.

551.5

12174 RELATION OF TURBULENCE THEORY TO IONOSPHERIC SCATTER PROPAGATION EXPERIMENTS.

D.Wheelon.

geophys. Res., Vol. 64, No. 12, 2230-1 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 ee Abstr. 10417 of 1960).

551.5

12175 MEASUREMENTS OF TURBULENCE IN THE 80- TO 100-km REGION FROM THE RADIO ECHO OBSER- ATIONS OF METEORS.

J.S.Greenhow and E.L.Neufeld.

geophys. Res., Vol. 64, No. 12, 2129-33 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 ee Abstr. 10417 of 1960). Measurements of irregular winds at ights of 80 to 100 km, using radio echoes from meteor trails, are scribed. Large irregularities with a vertical scale of 6 km, a hori- ntal scale of the order of 150 km, and a time constant of 6×10^3 sec e observed. The r.m.s. wind velocity associated with these irregu- rities is 25 m sec^{-1}. Turbulent wind shears of the order of m sec^{-1} km^{-1} are found, although occasionally shears as high as 0 m sec^{-1} km^{-1} are observed. Lower limits for the scale and time nstant of the smallest eddies are determined.

551.5

12176 SCATTERING OF WAVES AND MICROSTRUCTURE OF TURBULENCE IN THE ATMOSPHERE.

A.M.Oboukhov.

geophys. Res., Vol. 64, No. 12, 2180-7 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 ee Abstr. 10417 of 1960). A brief survey of the theory of scattering waves by turbulent inhomogeneities. Experiments on the study scattering phenomena of sound by turbulence in the surface layer the atmosphere are discussed. These experiments were carried t to obtain some information on the turbulent spectrum; their sults are compared with the data of meteorological measurements the surface layer. Applying the method of scattered radio waves the study of turbulence in the ionosphere is discussed.

551.5

12177 THE EFFECT OF TURBULENT DIFFUSION IN THE DIRECTION OF THE WIND UPON THE DISTRIBUTION CONCENTRATION OF MATERIAL WHICH IS SPREADING IN IE ATMOSPHERE.

I.L.Karol'.

kl. Akad. Nauk. SSSR, Vol. 131, No. 6, 1283-6 (April 21, 1960). In ssian.

The rate of progress of turbulent diffusion is determined by a mi-empirical equation of the form of the diffusion equation. This uation is solved in order to make an estimate of the influence of fusion on the distribution of matter as distinct from convection of atter by wind. Discussion of the result shows that there are stances in which the effect of diffusion must not be neglected.

R.Eisenschitz

551.5 : 532.5

TURBULENCE IN SHEAR FLOW IN A STABLE ATMOSPHERE.

e Abstr. 10640

551.5

12178 INTERPRETATION OF SOME FEATURES OF LOW-FREQUENCY IONOGRAMS.

J.M.Watts.

atmos. terrest. Phys., Vol. 15, No. 1-2, 73-6 (1959).

A number of features of ionograms in the range 50 kc/s to Mc/s are explained in terms of a simple ray theory incorporating calculation of ray retardation.

R.D.Davies

551.5 : 621.391.812.63

12179 THE JOINT USE OF THE ORDINARY AND EXTRAORDINARY VIRTUAL HEIGHT CURVES IN DETERMINING IONOSPHERIC LAYER PROFILES.

L.R.O.Storey.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 2, 111-24 (March-April, 1960).

An extension of Budden's matrix method for determining ionospheric layer profiles is described. When analysing vertical incidence ionograms by the matrix method, it is usual to interpret the virtual height curve for the ordinary mode only. Errors then arise from the presence in the lower ionosphere of low-density ionization for which the plasma frequency is less than the lowest frequency observed. In the proposed extension of the method, such errors are reduced by making use of the extraordinary virtual height curve as well as of the ordinary.

551.5 : 523.16

12180 THE QUESTION OF RADIO EMISSION BY THE IONOSPHERE.

J.L.Pawsey.

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 51-3 (1959).

The various reports of radio emission by the ionosphere are reviewed. It is pointed out that evidence for non-thermal emission is meagre although observations of Jupiter show that planetary atmospheres can be non-thermal radio emitters.

R.D.Davies

551.5 : 523.75

12181 IONOSPHERIC EFFECTS ASSOCIATED WITH THE SOLAR FLARE OF JULY 10, 1959.

V.A.W.Harrison.

Nature (London), Vol. 186, 228-9 (April 16, 1960).

A flare of importance 3+ on this date was accompanied by a large simultaneous change in f min. due to an increase in the electron density of the D-layer. An increase in the value of f_oF2 was also thought to be associated with the flare.

R.D.Davies

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12182 DRIFT IN THE E-REGION.

K.Rawer.

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 141-4 (1959).

Considers two models which could explain E-region drifts. One supposes the deformation is localized at a point, and the other supposes a line deformation. These models are compared with observations.

R.D.Davies

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12183 TIDES IN THE F-LAYER.

G.J.Gassmann.

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 99-101 (1959).

A world-wide three dimensional plot of the F-layer (i.e. electron density versus true height, versus latitude and versus local time) was obtained for the September period 1955. The pattern shows significant changes from day to day. The diurnal variations are explicable in terms of present theories of solar tide variations.

R.D.Davies

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12184 GEOMORPHOLOGY OF SPREAD F AND CHARACTERISTICS OF EQUATORIAL SPREAD F.

R.W.H.Wright.

J. geophys. Res., Vol. 64, No. 12, 2203-7 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). Between magnetic latitudes 20°N and 20°S there is a well-defined region where spread F is a normal occurrence on magnetically quiet days. Equatorial spread F is a night-time phenomenon that begins between 1900 and 2200 by a characteristic doubling of the layer and an increase in virtual height, indicating a vertical velocity. Later in the night, after 2300, the records show group retardation and no stratification. The occurrence of equatorial spread F is decreased by magnetic activity. Radio-star scintillations in equatorial regions are correlated strongly with spread F and have the same diurnal variation and the same anticorrelation with magnetic activity. The phenomenon of "flutter" (rapid fading of long-distance, high-frequency stations) shows the same variations. Measurements using the spaced receiver method indicate that, in the equatorial region, the irregularities in the F layer are greatly elongated along the lines of the earth's magnetic field.

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12185 MAGNETOHYDRODYNAMICS OF THE SMALL-SCALE STRUCTURE OF THE F REGION.

J.P.Dougherty.

J. geophys. Res., Vol. 64, No. 12, 2215-16 (Dec., 1959).

Fluid Mechanics in Ionosphere, Cornell University, July, 1959 (see Abstr. 10417 of 1960). The influence of the E region on Martyn's model (Abstr. 11650 of 1959; 12162 of 1960) for the explanation of radio-star scintillations and spread F is briefly discussed.

551.5

12186 DIURNAL VARIATION OF DEVIATIVE ABSORPTION IN THE F_2 REGION OF THE IONOSPHERE. S.K.Sharma.

Indian J. Phys., Vol. 32, No. 6, 297-8 (June, 1958).

Deviative absorption in the F_2 region has been studied by using frequencies near the critical frequency. The diurnal variation shows a minimum around noon, which occurs earlier for the lower frequencies, and this is attributed to thermal expansion of the layer.

G.M.Brown

551.5

12187 A MODEL OF THE F REGION ABOVE $h_{max}F2$.

J.W.Wright.

J. geophys. Res., Vol. 65, No. 1, 185-91 (Jan., 1960).

A simple Chapman model (scale height 100 km) of the ionosphere above the peak of the F region is found to be in good agreement with the few observed profiles of this region. The ratio of the above-peak electron content implied by the model to below-peak electron content is found to vary from about 2.8 to 4.0, also in good agreement with observations. The model is used in conjunction with electron density profiles observed from the ground to construct meridional cross-sections along the 75° W geographic meridian.

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12188 RADIATION BELTS AROUND THE EARTH.

J.A.Van Allen

Sci. American, Vol. 200, No. 3, 39-47 (March, 1959).

A non-specialist review of the information on the Van Allen belts gained by Explorers I, III and IV, and Pioneers I and III; and an account of the instruments carried (plastic and CsI scintillators, shielded and unshielded G.M. counters) and the methods of telemetry used to transmit the data back to earth.

551.5 : 525

12189 RADIATION MEASUREMENTS TO 658 300 km WITH PIONEER IV. J.A.Van Allen and L.A.Frank.

Nature (London), Vol. 184, 219-24 (July 25, 1960).

The structure of the outer zone (60 000-90 000 km) of trapped radiation, determined from data from Pioneer IV on March 3, 1959, shows a considerably greater intensity than that obtained from the flight of Pioneer III on Dec. 6-7, 1958. This is considered to be direct evidence of changes associated with strong solar corpuscular emission known to have occurred in the interval between these measurements, and to constitute strong support to the belief that the outer radiation zone has a solar origin. Other topics discussed include trapped radiation in the vicinity of the moon, cosmic ray intensity in interplanetary space, and the effective extent of the geomagnetic field.

G.M.Brown

551.5 : 525

OBSERVATIONS OF IONIZATION INDUCED BY ARTIFICIAL EARTH SATELLITES. See Abstr. 10540

551.5

12190 AURORAE SEEN IN DAYLIGHT.

J.Paton.

J.Brit. Astron. Assoc., Vol. 70, No. 3, 147-8 (March, 1960).

A critical comment on a recent summary of records of daylight aurorae [Botley, J.Brit. Astron. Assoc., Vol. 69, No. 5, 222-5 (1959)]. A similar phenomenon witnessed by the author on 3 September 1959 is described. In this instance it was certain that no connection existed between the rayed bands seen in daylight, and the rayed aurora seen in an identical position during the ensuing night. The daylight "rays" were due undoubtedly to shadow bands cast by broken cumulus cloud on the hazy sky background.

D.R.Barber

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12191 SOME PROPERTIES OF THE LUMINOUS AURORA AS MEASURED BY A PHOTOELECTRIC PHOTOMETER.

W.B.Murcray.

J. geophys. Res., Vol. 64, No. 8, 955-9 (Aug., 1959).

Intensity of the auroral radiation from the entire sky as a function of time was monitored photoelectrically at College, Alaska. Measurements extended over two years. Very good correlation was found between the 3914 A band of N_2^+ and the 5577 A line of OI. An intensity-time curve of a typical auroral display is shown. A diurnal variation curve is obtained which is very consistent, giving the same form for weak, moderate, and strong aurorae, and showin no evidence of seasonal variation. A rapid fluctuation in the intensi of radiation is reported.

551.

12192 NOTE ON AURORAL MOTION.

W.A.Feibelman.

J. geophys. Res., Vol. 64, No. 9, 1328-30 (Sept., 1959).

An auroral display of moderate intensity and extent observed on the night of March 28-29, 1959, showed several detached bright ray-bundles that traversed the sky from E to W with a rapid motion One such ray system showed a linear displacement of 9 degrees/minute, corresponding to a velocity (at 100 km) of 1 km/sec.

D.R.Barbe

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12193 AURORA OF MAY 4-5, 1959 (No. 24).

W.A.Feibelman.

J. geophys. Res., Vol. 64, No. 9, 1331 (Sept., 1959).

During a moderately strong display (brightness 2) seen at Pittsburgh, U.S.A., the appearance of an unusually deep red ray at 23.15 E.D.T., and a number of red-tipped green rays at 23.30 E.D.T coincided with abrupt changes in magnetograph tracings, and in the records of a radio receiver recording atmospheric enhancement at 27 kc/s.

D.R.Barbe

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12194 REMARKS ON AURORAL ISOCHASMS.

E.H.Vestine and W.L.Sibley.

J. geophys. Res., Vol. 64, No. 9, 1338-9 (Sept., 1959).

Recently Hultquist (Abstr. 793 of 1960 and 6383 of 1959) has shown that the projections of geomagnetic lines of force from a circular zone lying in the equatorial plane intersect the earth's surface in a pattern similar to that of the polar auroral isochasms of Vestine (Abstr. 729 of 1945). Agreement is very good except in the Hudson Bay area of N. Canada where the "fit" is improved by using Gartlein's more recent data (1959). The present note sugges that if auroral particles drain, as is now supposed, into the polar regions from the Van Allen radiation belt the Hudson Bay modification is to be expected.

D.R.Barbe

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12195 ARTIFICIAL AURORAS RESULTING FROM THE 1958 JOHNSTON ISLAND NUCLEAR EXPLOSIONS.

J.M.Malville.

J. geophys. Res., Vol. 64, No. 12, 2267-70 (Dec., 1959).

Beta decay electrons travelling along magnetic lines of force a shown to be capable of accounting for the artificial aurora which appeared at the conjugate point of Johnston Island after the explosi of August 1. Dissociative recombination and ion—atom interchang are suggested as the primary exciting mechanisms of the oxygen forbidden lines in the artificial auroral rays and may account, wher combined with collisional de-excitation, for the observed violet colour of the rays. The high-altitude arc may be a form of auroral afterglow and may result from a process similar to that which enhances the oxygen red lines in twilight.

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12196 FALL-DAY AURORAL-ZONE ATMOSPHERIC STRUCTURE MEASUREMENTS FROM 100 TO 188 km.

R.Horowitz, H.E.LaGow and J.F.Giuliani.

J. geophys. Res., Vol. 64, No. 12, 2287-95 (Dec., 1959).

The density and pressure of the atmosphere from 100 to 188 k above Fort Churchill, Manitoba, Canada, were determined from the I.G.Y. NN 3.15 Aerobee-Hi rocket flight on October 31, 1958, at 2:00 p.m., C.S.T. Two magnetic cold-cathode ionization gauges were used to measure pressure and pressure changes on the side of the rolling rocket. Excellent agreement was obtained (a) betwee the two gauges throughout flight, and (b) between ascent and descen measurements. Measured pressures in the region from 100 to 112.5 km were corrected for a residual gas pressure of approximately 3×10^{-6} mm Hg. An ambient pressure of 10^{-4} mm Hg was obtained at 106 km. The derived pressure of 2.3×10^{-6} mm Hg at 188 km is approximately a factor of 2 lower than the correspond ing arctic summer-day value. Densities were measured from 130 to 188 km. The density value of 5.2×10^{-7} g/m^3 at 188 km is approximately 40% lower than the summer-day value. The density profile presented here is in good agreement with the arctic Novem day density point obtained at 200 km in 1956. Scale heights (RT M ere derived from the measured pressure and density data versus titude, using the hydrostatic equation. The scale-height value btained at 188 km was 63 km, and the scale-height gradient from 30 to 188 km was 0.5 km/km.

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12197

AURORA OF OCTOBER 22/23, 1958, AT RAPID CITY, SOUTH DAKOTA. F.E.Roach and E.Marovich.

Res. Nat. Bur. Stand., Vol. 64D, No. 2, 205-9 (March-April, 1960).

During the night of October 22/23, 1958, auroral activity at apid City, South Dakota, included (a) a visible aurora in the northern art of the sky and; (b) a "monochromatic" (6300 A) arc through the enith with an azimuth 12° from east-west (geomagnetic). The tensity changes of the arc were independent of the changes in the isible aurora. It moved slowly southward during the night corres- onding to a linear speed of about 8 m sec^{-1} if its height is 300 km. Is suggested that it is a member of a family of monochromatic rcs which have until recently escaped detection because their red olour makes them invisible even though intrinsically intense.

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12198

GEOMETRY OF THE SOUTHERN AURORAL ZONE AND THE EVIDENCE FOR THE EXISTENCE OF AN INNER ONE. T.Hatherton.

ature (London), Vol. 186, 288-90 (April 23, 1960).

The spatial distribution of auroral activity recorded during 1957 Scott Base and at Hallett Station in Antarctica supports the hypo- esis of the existence of an inner zone in the southern aurora entred near the South Geomagnetic Pole. R.W.Nicholls

551.5

12199

THE DISTRIBUTION OF RADIO-AURORA IN CENTRAL CANADA. P.A.Forsyth, F.D.Green and W.Mah.

anad. J. Phys., Vol. 38, No. 6, 770-1 (June, 1960).

Five bistatic v.h.f. radio systems were operated in central Canada uring the I.G.Y. for the purpose of detecting auroral ionization. Con- stent records were obtained for a period of 5 months and these ecords have now been analysed. Two types of events were detected. he nighttime (A) events occur most frequently in the auroral zone id characteristically are observed simultaneously at two points eparated by about 300 km. The daytime (S) events occur simul- aneously over a much larger area. The time of maximum occurrence A events becomes later with decreasing latitude whereas the re- erse is true for S events. The variation with latitude of the occur- ence of A events is similar to that of other auroral phenomena.

551.5

12200

SOUTHERN-HEMISPHERE OBSERVATIONS OF SODIUM EMISSION THROUGHOUT TWILIGHT. B.J.O'Brien.

. geophys. Res., Vol. 65, No. 1, 137-40 (Jan., 1960).

A report is given of preliminary measurements in Melbourne and ntarctica of the twilight and nightglow sodium emissions. These bservations were part of the programme of the Australian National ntarctic Research Expeditions. A photometer with a filter of 4 A ndwidth was used. Continuous measurements of the intensity were egun when the earth's shadow was about 20 km above the earth. The ight of the sodium layer causing the twilight emission was about 0 km in both Melbourne and the Antarctic. The ratio of twilight tensity to the nightglow intensity at the end of twilight varied etween 15 and 50. It is suggested that further study of the ratio ay clarify several problems associated with the nightglow.

551.5

12201

A RELATIONSHIP BETWEEN THE LOWER IONOSPHERE AND THE [O I] 5577 NIGHTGLOW EMISSION. W.McCaulley and W.S.Hough.

geophys. Res., Vol. 64, No. 12, 2307-13 (Dec., 1959),

The results of a study comparing 5577 A airglow intensity with nosphere characteristics, using observations near Boulder, olorado, are presented. The analysis suggests that 5577 variations airglow intensity can be correlated with variations of an iono- pheric stratum. This stratum, as observed by low-frequency sweep undings, is in the 90 to 110 km region. It is concluded that the servations do not uniquely support any one excitation mechanism r the 5577 emission.

551.5

12202

CERTAIN DATA ON THE POLARIZATION OF LIGHT BY THE ATMOSPHERE. E.V.Pyaskovskaya-Fesenkova.

okl. Akad. Nauk SSSR, Vol. 131, No. 2, 297-9 (March 11, 1960). Russian.

Observations were made with a visual photometer from three different places (and altitudes). On some days the degree of polarization could be represented satisfactorily by using Rayleigh's formula multiplied by a suitable constant. The dispersion of light into natural and polarized rays is also investigated briefly. G.A.Chisnall

551.5

12203

A SYNOPTIC STUDY OF INFRA-RED RADIATION OVER THE UNITED STATES. J.L.Gergen and W.L.Huch.

Nature (London), Vol. 186, 426-9 (May 7, 1960).

25 U.S.A. Weather Bureau stations sent aloft Black Ball flights on the nights 26-30 May, 1959. The total radiation incident on a roughly spherical surface gave a measure of the radiation temperature at very high levels and is related to the total outgoing energy from the Earth and atmosphere below. Isopleths of constant power per unit area lost to space are drawn as a function of geography over U.S.A. It is concluded (1) the observed power loss to space is not obviously dependent on the total atmospheric moisture or on latitude, only weakly dependent on weather systems, and strongly dependent on cloud cover, (2) variation in power-loss to space over a relatively small geographical region on any one night is at least as large as the variation in the mean power-loss to space from equator to poles, and for any one location from one night to the next, (3) since infrared radiation is the only mechanism by which the Earth can lose to space the energy it gains from solar illumination, the observed power-loss to space, which varies by a factor of 2 over very small distances, must significantly affect the formation and propagation of weather systems. Assuming that the net radiation unbalance over latitude is responsible for the generation of weather systems and air motions, then the large radiation differences occurring over small geographical regions play an important part in controlling and modifying the weather systems existing there. R.S.Read

551.5 : 535.33

ULTRAVIOLET SPECTRAL ENERGY DISTRIBUTIONS OF NATURAL SUNLIGHT AND ACCELERATED TEST LIGHT SOURCES.

See Abstr. 10769

551.5 : 523.5

12204

DECAY OF LIGHT FROM A METEOR TRAIN. G.S.Hawkins and W.E.Howard.

Astrophys. J., Vol. 130, No. 3, 1008-20 (Nov., 1959).

The rate of decay of light from a persistent meteor train was measured using a microdensitometer. The decay followed an exponential law at all measured points, and these points were located between heights of 84 and 93 km above the earth's surface. At 93 km the light decayed at a rate of 0.2 magnitudes per second; at 84 km the rate was 1.2. Evidence of radiation from atomic oxygen was found in the early part of the decay curve. A comparison of normal and long enduring trains shows that the rate of decay is controlled by the upper atmosphere and is not dependent on the properties of the meteor that produced the train.

551.5 : 621.391.812.62

12205

AN ANALYSIS OF TIME VARIATIONS IN TROPOSPHERIC REFRACTIVE INDEX AND APPARENT RADIO PATH LENGTH. M.C.Thompson, Jr., H.B.Janes and A.W.Kirkpatrick.

J. geophys. Res., Vol. 65, No. 1, 193-201 (Jan., 1960).

The results of a series of measurements for a study of the characteristics of the turbulent lower atmosphere and its effect on the accuracy of radio direction-finding, guidance, and geodetic measurement systems are presented. One experiment consists of recordings of refractive index and apparent path length variations at 9400 Mc/s over a 15.5 mile path on Maui, Hawaii and the other two experiments consist of similar measurements made over a 9.5 mile path near Boulder, Colorado. The correlation of refractive index and apparent path length fluctuations is discussed as well as the power (variance) density spectra of both variables.

551.5

12206

OBSERVATIONS OF ATMOSPHERIC RADIO NOISE. G.R.A.Ellis.

Nature (London), Vol. 186, 229 (April 16, 1960).

Comparison of 5 kc/s radio noise records obtained at Camden, N.S.W., and 2.5 kc/s records at Kiruna, Sweden, shows that both stations detected a noise storm following a geomagnetic sudden commencement at 0035 G.M.T. on 5 Dec., 1958. This suggests that there is a world-wide pattern of noise illumination during magnetic disturbances. G.M.Brown

551.5

12207 A COMPARISON OF SFERICS AS OBSERVED IN THE VERY LOW FREQUENCY AND EXTREMELY LOW FREQUENCY BANDS. L.R.Tepley.

J. geophys. Res., Vol. 64, No. 12, 2315-29 (Dec., 1959).

A large number of sferics were photographically recorded in the very low frequency (v.l.f.) and extremely low frequency (e.l.f.) bands at a U.C.L.A. field station in Hawaii. From the characteristic v.l.f. waveforms it was clear that the v.l.f. signals were generated from lightning discharges. It was found that an observable e.l.f. component (slow tail) followed the v.l.f. component in almost all cases. It was also found that about one third of the sferics observed were e.l.f. signals, similar in appearance to slow tails but not preceded by observable v.l.f. oscillations. Peak amplitudes were measured for both the v.l.f. and e.l.f. components of almost 3000 sferics. The results were tabulated in groups according to (1) whether the sferics were recorded during the day or during the night, (2) whether the polarity of the initial excursion of the e.l.f. signal was positive or negative, and (3) whether the v.l.f. and e.l.f. components appeared together or separately. Amplitude distribution histograms were plotted for all cases. For those sferics possessing both v.l.f. and e.l.f. components, the v.l.f. to e.l.f. peak amplitude ratios were also tabulated separately as in (1) and (2) above, and ratio-distribution histograms were plotted. The more important results obtained from the histograms were as follows. No significant differences were found between the amplitude distributions for the e.l.f. waveforms that were preceded by v.l.f. oscillations and those that were not. Hence, it is probable that both groups were generated by lightning discharges. For both daytime and night-time sferics the median value of the e.l.f. amplitude was greater for e.l.f. waveforms of positive polarity than for waveforms of negative polarity. For both daytime and night-time sferics the median value of the v.l.f./e.l.f. peak-amplitude ratio was greater for e.l.f. waveforms of negative polarity than for waveforms of positive polarity. The polarity of the e.l.f. waveform was predominantly negative at night and positive during the day (verified by a count of the polarities of almost 6000 additional e.l.f. waveforms). An attempt is made to explain the experimental results in terms of known properties of lightning discharges, and some of the difficulties in making such an interpretation are indicated.

551.5

12208 WHISTLERS.
M.G.Morgan.

J. atmos. terrest. Phys., Vol. 15, No. 1-2, 54-7 (1959).

Observations are cited to confirm the theory that whistlers are propagated via the Earth's magnetic lines of force from one hemisphere to the other. The propagation of more than one whistler from a given lightening flash and the latitude dependence of whistlers are discussed. R.D.Davies

551.5 : 550.3

12209 CORRELATION OF OCCURRENCE OF WHISTLERS WITH GEOMAGNETIC ACTIVITIES. A.Kimpara.

Nature (London), Vol. 186, 230 (April 16, 1960).

Determination of lag correlation coefficients between whistler data for Wakkanai and geomagnetic K indices for Kakioka shows that, for the winter months only, the highest coefficient is obtained for whistler data lagging geomagnetic data by 2 days. G.M.Brow

551.

12210 AN APPARENT SOLAR PERIODICITY IN RADIO STAR SCINTILLATION. W.D.Ryan and G.A.Harrower.

Canad. J. Phys., Vol. 38, No. 6, 883 (June, 1960).

A periodicity of about 27 days observed in the scintillation ind of Cygnus A suggests that solar activity contributes directly to the ionospheric processes responsible for the scintillation of radio sta at least in or near the auroral zone. C.Hazar

551.

12211 THE SCINTILLATION OF RADIO SIGNALS FROM SATELLITES. K.C.Yeh and G.W.Swanson, Jr.

J. geophys. Res., Vol. 64, No. 12, 2281-6 (Dec., 1959).

Signals from satellites $1957\alpha_2$ and $1958\delta_2$, recorded during a 20 month period, are analysed to determine the diurnal and seaso variations of the incidence of scintillation. Marked diurnal effects are noted, scintillation being much more frequent at night. Night-time scintillation correlates with the occurrence of ionospheric "spread F" and apparently originates in inhomogeneities at heights of about 220 km and, in most cases, at latitudes greater than 40° N. Daytime scintillation appears to originate in smaller, inhomogeneo regions below 220 km and more widely distributed in latitude.

551.5 : 621.391.

12212 SOME E.L.F. [EXTREMELY LOW FREQUENCY] PHENOMENA. E.T.Pierce.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 383-6 (July-Aug., 1960).

Properties of the electric and magnetic fields in natural extremely low frequency phenomena are briefly discussed. The e.l.f. fluctuations in the electric field are then treated from two aspects; the electromagnetic changes associated with atmospherics and the electrostatic variations in atmospheric electricity. A final section attempts to integrate the general subject of e.l.f. effects of natural origin.

551.

12213 NATURAL ELECTROMAGNETIC ENERGY BELOW TH ELF RANGE. W.H.Campbell.

J. Res. Nat. Bur. Stand., Vol. 64D, No. 4, 409-11 (July-Aug., 1960).

The transition of natural signals from sferics slow tails to geomagnetic micropulsations was observed between 2.0 and 0.2 c/s. Micropulsations with periods of 5 to 30 sec have characteristics which closely relate to solar terrestrial disturbance phenomena. The low latitude diurnal amplitude variation has maximums at 0945 and 1000 l.m.t. Similar groups of oscillations appear in Alaska and California. Simultaneous pulsation of λ 3914 aurora and magnetic field micropulsations has been observed in Alaska.

BIOPHYSICS · PHYSIOLOGICAL PHYSICS

61

12214 MAGNETISM IN MEDICINE.

M.W.Freeman, A.Arrott and J.H.L.Watson.

. appl. Phys., Suppl. to Vol. 31, No. 5, 404S-405S (May, 1960).

The applications of magnetic materials and magnetic fields in edicine are reviewed. Direct biological effects of magnetic fields, inical uses of the mechanical force exerted by magnets, and mag-etic analysis as a tool in biochemistry are considered. The authors' pplications of the technology of fine particle iron to the treatment cancer and mental disease, for investigation of basic biochemistry nd for diagnostic purposes are discussed. A significant step in these pplications has been the discovery of sublingual assimilation of fine article iron.

61

12215 MAXIMUM PERMISSIBLE INTERNAL DOSE OF RADIONUCLIDES: RECENT CHANGES IN VALUES.

.Z.Morgan.

uclear Sci. Engng, Vol. 1, No. 6, 477-500 (Dec., 1956).

The development of dose rate standards and dosage units is riefly described. The recommendations of the April, 1956 meeting f the International Commission on Radiological Protection are ummarized and the effects of these recommendations on operations f large atomic energy installations are discussed. It is concluded at, because of the conservative practice of health physics in the ast, the new ICRP proposed changes in exposure standards will not equire any major alteration of current practices.

61

12216 GATING SYSTEM FOR PHOTOGRAPHIC PRINTOUT OF COUNTS IN NEUROPHYSIOLOGICAL RESEARCH.

.Eisenberg and F.Ratliff.

ev. sci. Instrum., Vol. 31, No. 6, 630-3 (June, 1960).

An electronic gating system is described which enables the hotographing of an instantaneous numeral display of either the time arrival of nerve impulses, or the time interval between successive mpulses, superimposed on the oscilloscope trace of the impulses. he electronic circuitry is based on commercially available decade ounters modified for the gating facility.

61 : 532.5

12217 BLOOD FLOW MEASUREMENTS USING DYNAMICAL PARAMAGNETIC RELAXATION TIMES AND PARA-IAGNETIC TRACER TECHNIQUES. J.R.Singer.

. appl. Phys., Suppl. to Vol. 31, No. 5, 406S-407S (May, 1960).

The effect of flow on the paramagnetic relaxation time of fluids s discussed. The saturation or magnetization inversion of a group f nuclear moments constitutes a short-lived tracer for these noments permitting flow velocity measurements. For long-lived racers, a given set of molecules with a well-known nuclear or lectron paramagnetic resonance spectrum may be employed. Ex-erimental measures of blood flow velocity in mice are discussed.

learing . Speech

612.7

12218 DURATION OF SYLLABLE NUCLEI IN ENGLISH.

G.E.Peterson and I.Lehiste.

. Acoust. Soc. Amer., Vol. 32, No. 6, 693-703 (June, 1960).

This study deals with the influence of preceding and following onsonants on the duration of stressed vowels and dipthongs in merican English. A set of 1263 CNC words, pronounced in an dentical frame by the same speaker, was analysed spectrographically, nd the influences of various classes of consonants on the duration f the nucleus were determined. The residual durational differences re analysed as intrinsic durational characteristics, associated ith each syllable nucleus. The theory is tested with a set of 30 inimal pairs of CNC words, uttered by five different speakers.

612.8

12219 AUDITORY DIFFERENTIAL INTENSITY SENSITIVITY [TO A SOUND] IN THE PRESENCE OF A CONTRA-ATERAL SOUND OF THE SAME FREQUENCY. R.Chocholle.

custica, Vol. 7, No. 2, 75-83 (1957). In French.

The response curves for a variation of intensity received at one ear, while the other is subject to a steady tone of the same frequency, have been studied. Examination of the curves, particularly of their slope in the region of 50% affirmative response, and of the differential thresholds, show that there is always some reduction of the differential sensitivity; this reduction increases with the intensity of the steady tone on the other ear. The origin of this effect must be cortical, and perhaps is a question of contrast.

612.8

12220 AUDITORY FACILITATION FOLLOWING STIMULATION AT LOW INTENSITIES. H.Rubin.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 670-81 (June, 1960).

Auditory thresholds may become lower (improve) following stimulation by sound of low intensity. This shift in threshold was determined by comparing the reference threshold of a test pulse, presented alone, to the threshold for the test pulse preceded by a stimulating pulse. Duration, intensity, and frequency of the stimulating pulses were controlled, as were duration and frequency of the test pulse and duration of the interval between pulses. For pulses of 1000 c/s, facilitation, or a lowering of the threshold, consistently follows stimulation by sound of 25 dB SL or less; the lower the stimulating intensity, the more widespread the facilitation, over the various poststimulatory intervals tested. Facilitation reaches a maximum of 5 to 7 dB 160 msec after the termination of the stimulating pulse, although some negative shift in threshold occurs after the longest interval (2 sec). Stimulation by white noise may depress the threshold for a pure tone, although a pure tone seems to have no effect upon the threshold for a white noise. When the stimulating pulse is a 1000 c/s tone, facilitation occurs for test tone between 500 and 2000 c/s. The maximal shift is at 160 msec for all test tones except 2000 c/s. The nature of the facilitatory process, auditory or attentional, and its locus, whether peripheral or central, are discussed.

612.8

12221 VALUE OF EAR DEFENDERS FOR MENTAL WORK DURING INTERMITTENT NOISE. M.M.Woodhead.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 682-4 (June, 1960).

Ear defenders were worn for protection against the distracting effects of bursts of loud, but not unacceptable, noise during a mental task. Two types of noise were used: one characterized by high and the other by low frequencies. Performance was better with defenders than without them. The improvement was particularly marked with the high-frequency burst.

612.8

12222 BINAURAL INTERACTIONS OF IMPULSIVE STIMULI AND PURE TONES. G.G.Harris.

J. Acoust. Soc. Amer., Vol. 32, No. 6, 685-92 (June, 1960).

The time versus intensity trade ($\Delta T/\Delta I$) in binaural lateralization was measured for pure tones and impulsive stimuli by the null method for high-pass and low-pass clicks at a repetition of 20 p.p.s. and pure tones of 200, 500, and 700 c/s. Mean sensation levels (SL) of 20, 30, and 40 dB and interaural intensity differences of 0, 4, and 6 dB were used. The data on four subjects indicate a difference between high-pass and low-pass clicks: for instance, $\Delta T/\Delta I \cong 0.025$ msec/dB for low-pass clicks below 1000 c/s and $I = 30$ dB SL, whereas at the same intensity $\Delta T/\Delta I \cong 0.060$ msec/dB for high-pass clicks above 4000 c/s. It is concluded that the time versus intensity trade is important for the localization of high-frequency impulsive stimuli. The interaural intensity difference also affects the ability to lateralize since the error of lateralization is least when both the interaural intensity difference and interaural time difference are zero. From the foregoing and from experiments with two lateralized images, it is concluded that the timing information used in binaural lateralization travels along frequency-dependent neural pathways. Any physiological timing signal must be able to explain this phenomenon.

612.8 : 621.395.61

12223 AN ENERGY THEORY OF DIRECTIONAL HEARING AND ITS APPLICATIONS IN STEREOPHONY.

H.Mertens.

E.B.U. Rev. A, No. 59, 22-33 (Feb., 1960).

Studies of sound diffraction around the head show that the resultant sound pressure amplitudes and phases provide directional information. Actual values are calculated, assuming the two ears to subtend an angle of 160° at the centre of a sphere of 21 cm diameter. The total impression at the two ears depends on both the spectral and time distribution of the sound energy at these points, but the time differences are the predominant effect at middle and low frequencies. Formulae are developed for the directional transfer function using Gabor signal theory, a Gaussian pulse being chosen as the best compromise signal for analytical purposes. The relations between the true and virtual source directions are calculated for both crossed and spaced microphone systems, the governing parameters being derived from the particular microphone arrangements used and the spacing of the two loudspeakers. The transfer function is largely independent of frequency for the crossed microphone system, but a considerable variation occurs for the spaced microphone system. This may account for the present tendency to use cardioid rather than omnidirectional microphones in order to improve low frequency discrimination in spaced microphone systems. Some experimental confirmation of the main results is given and the relation of the present work to earlier studies is discussed.

M.L.Gayford

612.8 : 621.395.61

12224 ACOUSTIC IMPEDANCE OF HUMAN EARS AND SOME ARTIFICIAL EARS. I.Nábělek.

Slaboproudy Obzor, Vol. 21, No. 4, 210-14 (1960). In Slovak.

The acoustic input impedance of the ears was measured by the standing-wave method by employing the Hall tube. The impedance was measured at 25 different frequencies in the range of 0.3 to 7.5 kc/s. Altogether 23 human ears were investigated: 15 left ears of males, 4 right ears of males, 2 left ears of females and 2 right ears of females. The age of the subjects was 20—33 and all the measurements were carried out at the sound level of 60-70 dB. The results of the measurements are shown in graphs; both the real and imaginary components of the impedance as a function of frequency are given. The results are compared with the impedance of the artificial ears of the C.C.I.T.T., the British General Post Office and the Italian Postal Adminstration. The discrepancies between the impedance of the human and the artificial ears are due to the fact that the artificial ears lack the second resonance (at about 3 kc/s) and that a human ear never adheres very closely to a receiver.

R.S.Sidorowicz

Vision

612.8

12225 ANALYSIS OF RETINAL FUNCTION BY A TWO-FILTER METHOD. G.Wald.

J. Opt. Soc. Amer., Vol. 50, No. 7, 633-41 (July, 1960).

Any two coloured lights are effective in some characteristic energy ratio for stimulating cones, and some other characteristic ratio for stimulating rods, owing to the different spectral sensitivities of these receptors. Such ratios can be used to assess precisely the contributions of rods and cones to visual responses. In these experiments a violet and a yellow test light are used in this way to analyse cone and rod participation in dark adaptation, and in the thresholds of the dark-adapted retina at various distances from the fixation point ("retinal profiles"). Also, since the human macular pigment absorbs the violet light and not the yellow, these lights can map the extent and depth of the yellow patch. A functional cross-section of the retina results, measuring separately rod and cone activities and macular pigmentation, that agrees reasonably well with histological descriptions. A considerable section of dark adaptation is shown to involve mixed cone and rod responses. Thresholds of the dark adapted eye near the foveal border are similarly mixed. Colour sensations at the threshold desaturate with the first participation of rods, and are wholly lost while cone activity is still prominent. The macular pigmentation becomes appreciable at some distance from the fixation point, and in this subject increases regularly in depth to a maximum in the central fovea.

612.

12226 NEW METHOD FOR RECORDING EYE MOVEMENTS. C.Rashbass.

J. Opt. Soc. Amer., Vol. 50, No. 7, 642-4 (July, 1960).

A method is described which uses the difference between the light scattering ability of the cornea and of sclera to control the position of a cathode-ray tube spot in such a way that its focused image is kept fixed to the limbus. It is particularly suited to horizontal movements in the range 0.1-10 deg. The speed of response is 5 msec.

612.8

12227 IN MEMORIAM: DEAN FARNSWORTH, CDR, MSC, USNR. NEW DERIVATION FOR THE DEUTERANOPIC COPOINT. H.von Schelling.

J. Opt. Soc. Amer., Vol. 50, No. 7, 645-7 (July, 1960).

It is assumed that deuteranopes cannot discriminate between re and green. A particular deuteranopic copoint is associated with any chosen colour triangle under this condition. The copoint is calculated for six colour triangles suggested in literature. The results fall only in two cases into the range found experimentally by Dean Farnsworth.

612.

12228 FIELD TRIAL OF 10° COLOR-MIXTURE FUNCTIONS. H.Wright and G.Wyszecki.

J. Opt. Soc. Amer., Vol. 50, No. 7, 647-50 (July, 1960).

The recently proposed 10° colour-mixture functions derived by Judd (1959) from the Stiles—Burch (Abstr. 4162 of 1959) and Speranskaya (1958) data have been tested on a MacAdam type binocular colorimeter in conjunction with a set of suitable coloured glass filters. The average colour matches obtained from 5 observers agree only in part with those predicted from the proposed 10° colour-mixture functions. Significant discrepancies were found in the blue, bluish-green, near-white, and green region of the colour gamut while good agreement was obtained in the yellow, orange, red and purple region. The results confirm similar findings reported by Wyszecki and Stiles—Wyszecki (1959).

612.8

12229 CORRELATION OF ACCOMMODATION BETWEEN THE TWO EYES. F.W.Campbell.

J. Opt. Soc. Amer., Vol. 50, No. 7, 738 (July, 1960).

Accommodation fluctuations as measured independently but simultaneously in both eyes of a given subject reveal a high degree of synchronization. This suggests that their source is not ocular, arising at, or centrally to, the conjoint innervation of the IIIrd nerves.

R.A.Weale

612.

12230 THEORETICAL STUDY OF SPATIAL VISION. I. N.Günther.

Optik, Vol. 17, No. 2, 90-7 (Feb., 1960). In German.

By means of a simplified model of the eye, equations are deduced from which it is possible to calculate the perspective distance at which an object under observation is presented to the eye.

TECHNIQUE . MATERIALS

669 : 539.2 : 537.311

12231 THE REMOVAL OF NICKEL FROM GERMANIUM. A.K.Mednikov.

Fiz. tverdogo Tela, Vol. 1, No. 12, 1860-2 (Dec., 1959). In Russian.

Ni was diffused into n-type single crystal speciments at temperatures in the range 700-850°C. The "gettering" effect of molten Pb of high purity was then studied at the same temperatures. Ni concentrations before and after Pb treatment were determined from Hall constant and electrical resistivity. Dislocation density ($1-2 \times 10^3/cm^2$) and diffusion length (L) were also studied. Molten Pb appears to be an effective "getter" for Ni. It was noted that L is not fully restored to its initial value by Pb treatment.

C.H.L.Goodma

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 63 (1960). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

A.E.I. tech. Monogr.
A.E.I. Technical Monograph (Formerly: B.T.H. Technical Monograph [B.T.H. tech. Monogr.]) — Associated Electrical Industries, Rugby.

Ann. Assoc. Internat. Calcul Analogique
Annales de l'Association internationale pour le Calcul Analogique — Publisher: Presses Académiques Européennes, 98 Chaussée de Charleroi, Brussels, 6.

Elin J.
Elin Journal (Being special edition of Elin-Zeitschrift) — Volksgartenstrasse 3, Vienna 1.

Sci. Engng Rev. Doshisha Univ.
Science and Engineering Review of Doshisha University (Formerly: Doshisha Engineering Review [Doshisha Engng Rev.]) — Science and Engineering Research Institute of Doshisha University, Kyoto.

J. Elisha Mitchell Sci. Soc.
Journal of the Elisha Mitchell Scientific Society — University of North Carolina, Chapel Hill, North Carolina.

Telefunken-Röhre
Telefunken-Röhre — Telefunken, Soflinger Strasse 100, Ulm/Donau.

CHANGE OF TITLE

B.T.H. tech. Monogr.
British Thomson-Houston Technical Monograph — Title changed to: A.E.I. Technical Monograph [A.E.I. tech. Monogr.] in 1960.

Doshisha Engng Rev.
Doshisha Engineering Review — Title changed to: Science and Engineering Review of Doshisha University [Sci. Engng Rev. Doshisha Univ.] with issue dated Vol. 1, No. 1, 1960.

UNIVERSAL DECIMAL CLASSIFICATION

In this volume of "Physics Abstracts", the Universal Decimal Classification numbers printed with each abstract are much briefer than in former volumes. This was announced in the January issue, and the comments of readers on the usefulness of these numbers were requested.

Very few comments indeed have been received up to the present time. A particular request is therefore made to readers to study the announcement on the first page of the January, 1960, issue, and to supply their observations as soon as possible. The procedure to be followed in next year's volume will be determined in the light of the comments received.

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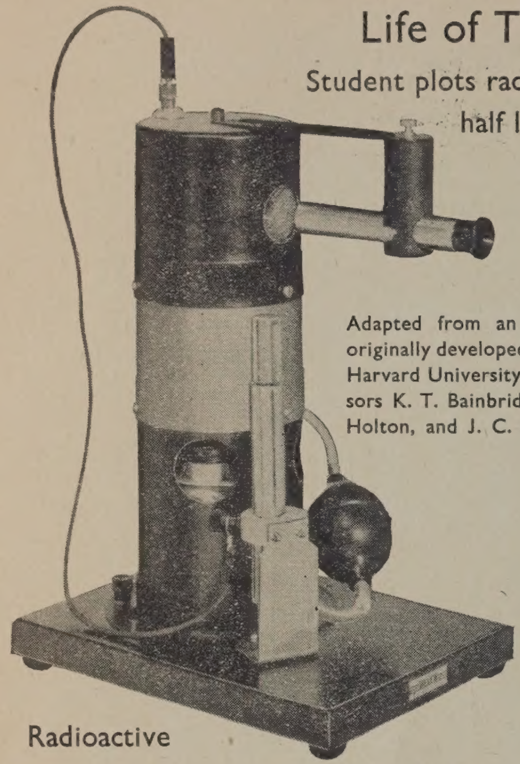

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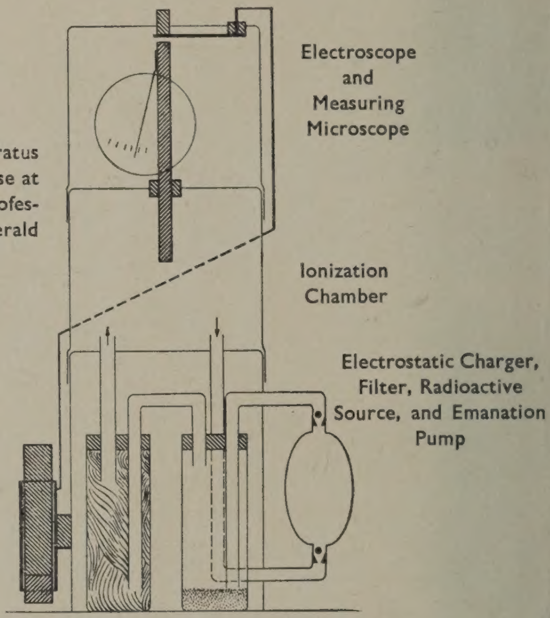
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The merit of this particular apparatus is that it is so simple to understand, to operate and to maintain. The radioactive material (thorium oxide) is included, one filling is adequate for years of use, and it never needs to be removed from the apparatus. It causes no contamination problem because it has low activity and is circulated in a system normally closed to the atmosphere.

The apparatus is approximately 14 inches high and is mounted on a 7 × 10 inch wooden base. The three chambers may be slipped apart for inspection of contents. The upper one contains two plastic windows for illuminating and viewing the leaf without admitting air currents. The unit may be stored without disassembly or other special attention and is ready for use at all times.

No. 619 EMANATION ELECTROSCOPE, Each **$60.00**

Recommended Accessories. No. 823A Stop Watch 1/2 second, Each $17.75. No. 824L Electric Stop Clock, Each $37.50

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